DOCUMENT RESUME

ED 199 533 CE 028 389

TITLE	Material Processing Handbook. The Wisconsin Guide to Local Curriculum Improvement in Industrial Education K-12.
INSTITUTION	Wisconsin State Dept. of Public Instruction, Madison. Div. of Instructional Services.
REPORT NO	WSDPI-Bull-1196
PUB DATE	[80]
NOTE	353p.
EDRS PRICE	MF01/PC15 Plus Postage.
DESCRIPTORS	Audiovisual Aids; Citations (References); Course Content; Curriculum Development; Elementary Secondary Education; Instructional Materials; *Learning Activities; Lesson Plans; *Production Techniques; *Resource Materials; Resource Units; State Curriculum Guides; *Trade and Industrial Education
IDENTIFIERS	*Wisconsin Guide Curriculum Improvement Indust Educ

ABSTRACT

This handbook is intended to aid industrial educators in developing material processing activities for their programs; it is especially designed to aid educators in implementing "The Wisconsin Guide to Local Curriculum Improvement in Industrial Education, K-12." The guide provides suggested outlines and models that could be used to structure a content area in materials and processes. Included are examples of lessons, written activities, processing activities, and group production activities. All activities are for the purpose of reinforcing instructional areas within the content outline and can be used in whole or in part or as a basis for further development. Also included are references, film lists, and a bibliography of text book suppliers, instructional resource suppliers, and film and film-strip sources. (KC)

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MATERIAL PROCESSING

HANDBOOK

THE WISCONSIN GUIDE TO
LOCAL CURRICULUM IMPROVEMENT
IN INDUSTRIAL EDUCATION K-12

Unit 2

THIS PROJECT WAS SUPPORTED BY FUNDS
APPROPRIATED UNDER THE
EDUCATIONAL AMENDMENTS OF 1976 - TITLE II
PUBLIC LAW 94-482
PROJECT #9-5516/L084

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Bulletin No. 1196

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PREFACE

This handbook is intended to aid industrial educators in developing material processing activities into their programs. The Material Processing Handbook is not a course of study, but rather a resource to aid in local improvement. It is designed to be used by educators to aid them in implementing The Wisconsin Guide to Local Curriculum Improvement in Industrial Education, K-12.

The content outlines, models, structures and activities can be utilized for courses, specific untis or for integrating material processing concepts throughout the inudstrial education program.

The materials included in this handbook come from a number of excellent resources that have been developed to improve material processing education. Where the sources were known credit is given for inclusion.

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RATIONALE:

A rationale is a reason for existence or prepared action. In curriculum development it answers the key question of "why" something is taught.

A rationale is thus a justification statement which highlights the importance of the program, course or unit which it is directed at.

The statement is generally short, concise and directly to the point. The rationale that follows in this resource handbook provides the user with a set of ideas to use in developing a statement for local use.

0 8

DESCRIPTION OF THE GUIDE

The design of this guide is to provide suggested outlines and models that could be used to structure a content area in materials and processes. Included are examples of lessons, written activities, processing activities, and group production activities. All activities are for the purpose of reinforcing instructional areas within the content outline and can be used in whole or in part or as a basis for further development. Also included are references, film lists, and a bibliography of text book supplies, instructional resource suppliers, and film, film-strip sources.

The intended purpose of this guide is for it to be used as an aid in implementing the Wisconsin Guide to Local Curriculum Improvement in Industrial Education Grades, K-12.

RATIONALE

All raw materials used in manufacturing come from nature in one form or another. Industries dependency on these materials in providing products and services for industrial and consumer use make it essential for us to study material in terms of:

Material location and exploration
Material extraction
Material properties and/or characteristics
Conversion of materials
Processing techniques
Research and development of new materials

CONTENT OUTLINES:

Content in any curriculum area can be structured in many different ways. In addition, the manner in which the content overview is communicated to other professionals can take on a variety of approaches.

Common approaches for communicating a curriculum structure, scope and sequence are usually in the form of outlines, models or a combination of the two.

The content structures that follow in this handbook are examples of different ways of communicating the subject to the profession.

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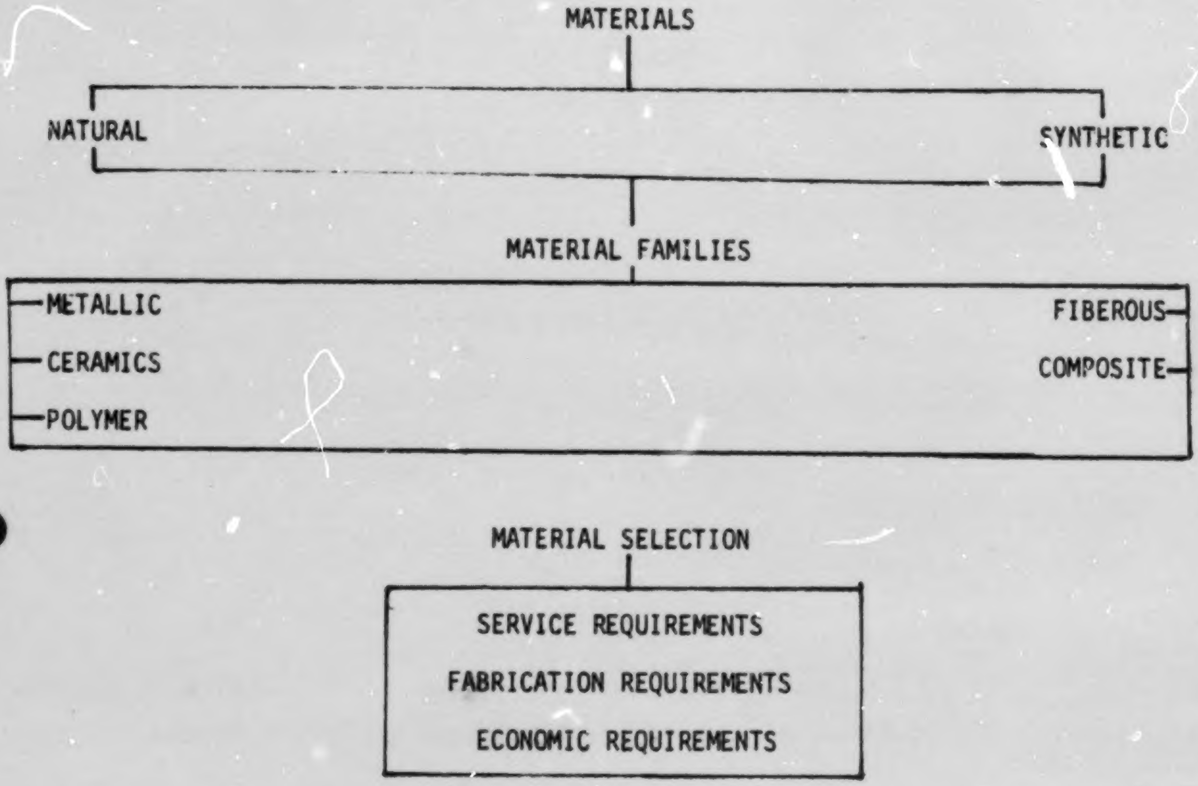
COURSE OUTLINE

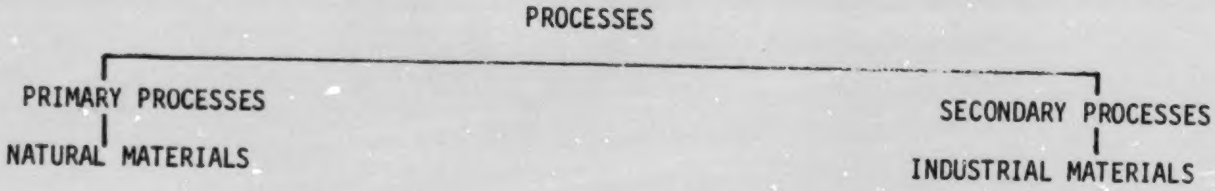
- I. Materials
    - A. Natural
        - 1. Solid
        - 2. Liquid
        - 3. Gas
    - B. Synthetic
        - 1. Mixture
        - 2. Compound
        - 3. Solution
        - 4. Alloys
    - C. Material Families
        - 1. Metallic
        - 2. Ceramic
        - 3. Polymer
        - 4. Fiberous
        - 5. Composite
    - D. Material Selection
        - 1. Service Requirements
        - 2. Fabrication Requirements
        - 3. Economic Requirements
- II. Processes
    - A. Primary Processes
        - 1. Natural Materials
            - a. Location - Grow
            - b. Extraction
                - 1) Mine
                - 2) Harvest
            - c. Separation
                - 1) Mechanical
                - 2) Chemical
                - 3) Electrical

B. Refine
    1. Raw materials
    2. Synthetic materials
C. Secondary processes
    1. Industrial Materials
        a. Properties
        b. Characteristics
    2. Industrial Processes
        a. Separation
        b. Forming
        c. Conditioning
        d. Combining
        e. Finishing

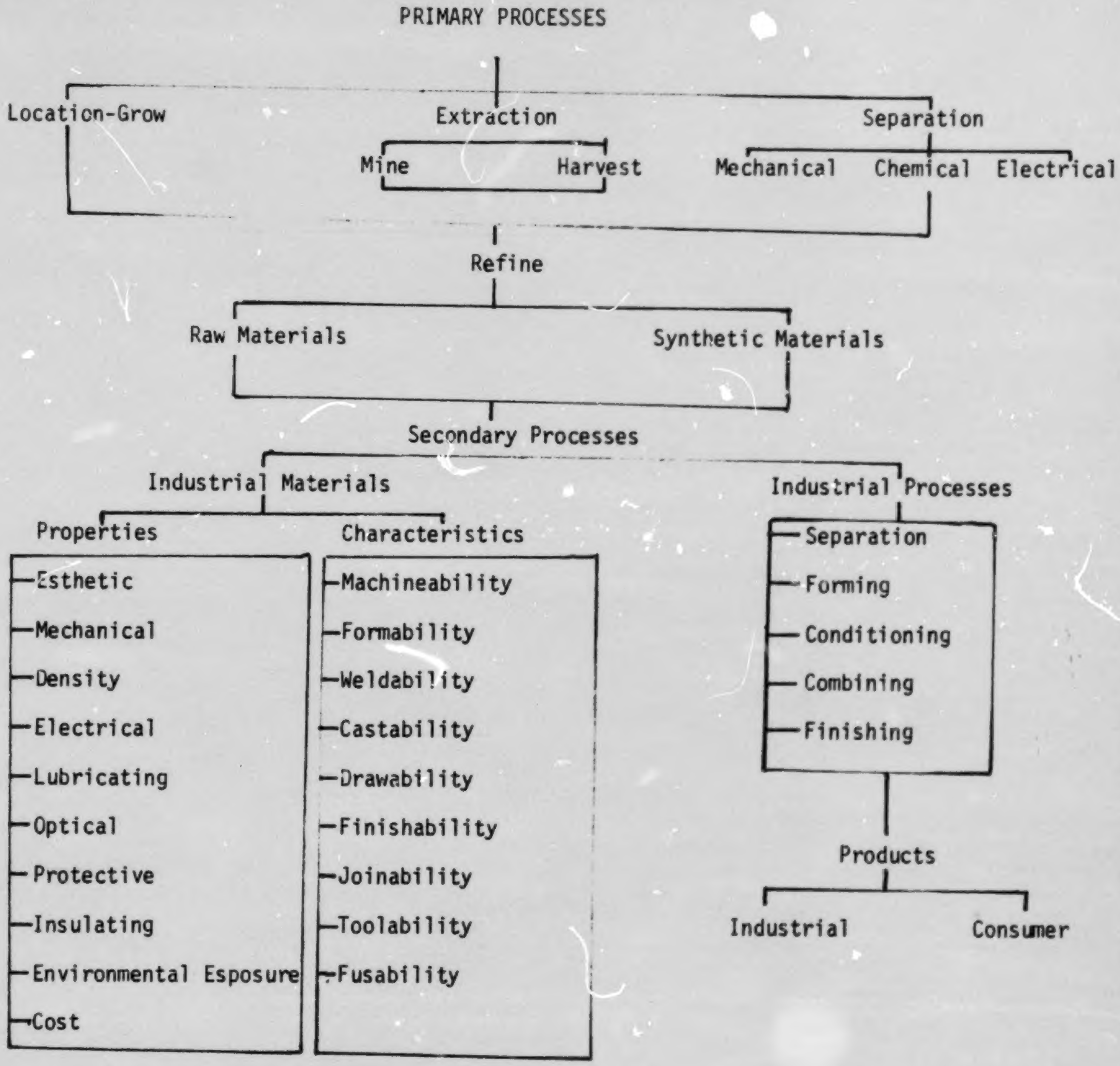
MATERIAL STRUCTURE


MATERIALS
NATURAL
SYNTHETIC
MATERIAL FAMILIES
METALLIC
CERAMICS
POLYMER
FIBEROUS
COMPOSITE
MATERIAL SELECTION
SERVICE REQUIREMENTS
FABRICATION REQUIREMENTS
ECONOMIC REQUIREMENTS

PROCESSES STRUCTURE


PROCESSES
PRIMARY PROCESSES
NATURAL MATERIALS
SECONDARY PROCESSES
INDUSTRIAL MATERIALS

(continued on following pages)


PRIMARY PROCESSES
Location-Grow
Extraction
Mine
Harvest
Separation
Mechanical
Chemical
Electrical
Refine
Raw Materials
Synthetic Materials
Secondary Processes
Industrial Materials
Properties
Esthetic
Mechanical
Density
Electrical
Lubricating
Optical
Protective
Insulating
Environmental Esposure
Cost
Characteristics
Machineability
Formability
Weldability
Castability
Drawability
Finishability
Joinability
Toolability
Fusability
Industrial Processes
Separation
Forming
Conditioning
Combining
Finishing
Products
Industrial
Consumer

INDUSTRIAL PROCESSES

The following pages cover a composite listing of industrial processes within the areas of:

Separation
Forming
Conditioning
Combining
Finishing

FORMING	SEPARATING	CONDITIONING
Peening	Screening	Coring
Rolling	Floating	Crystalizing
Drawing	Filtering	Heat Treating
Pressing	Magnetizing	Melting
Forging	Evaporating	Freezing
Stamping	Drying	Fermentation
Bending	Absorbing	
Extruding	Crushing	
Spinning	Turning	
Molding	Shaping	
Casting	Planing	
Blowing	Drilling	
Pressing	Boring	
Vacuum Forming	Broaching	
	Sawing	
	Abrading	
	Shearing	
	Etching	
	Burning	
	Punching	
	Engraving	
	Heat	
	Light	
	Milling	
	Chipping	

FINISHING

Spraying
Brushing
Rolling
Dipping
Printing
Dyeing
Calendar Coating
Oxide Coating
Enameling
Buffing
Burnishing
Flame Finishing
Electro Deposition

COMBINING

Mixing
Beating
Agitation
Atomization
Compounding
Assembling - Fastening (joining)
Laminating
Felting
Welding
Brazing
Soldering
Pinning
Shrinking
Pressing
Bonding
Mechanical fasteners
(thread and non-thread)

MATERIALS AND PROCESSING

UNIT II - CLASSIFICATION OF MATERIALS
UNIT III - FORMING MATERIALS
UNIT IV - SEPARATING MATERIALS
UNIT V - COMBINING MATERIALS
UNIT VI - FINISHING MATERIALS
UNIT VII - DEVELOPMENT OF PRODUCTS

Extracted from The Materials And Processes of Industry Guide. Louisiana State Department of Education and adopted from the Material And Processes Guide, Kansas State Department of Instruction.

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
Unit II - Classification of Materials	The student will be able to explain a materials classification system and its purpose. The student will be able to define the following generic materials titles: (1) Metals (Ferrous and Non-ferrous) (2) Non-metals (Organics and Inorganics)	Discussion-demonstration. From a list of material captions and definitions the student will make a display chart depicting the system of materials classification. The display chart will be of heavy colored paper and will be placed in the student notebook. See Appendix II for list of material captions and a classification system for metals. Handouts should be made with materials in appendix whenever needed.	See Appendix II-p. 30-31
I. Metals	The student will be able to do the following: (1) Discuss extraction and refining practices (2) Differentiate ferrous and non-ferrous (3) Differentiate elements and alloys (4) Describe distinguishing parameters of metals (5) Discuss metal identification procedure	Discussion-demonstration. The student will correctly label six metal coupons by subjecting them to visual, weight, magnetic, bend, and spark tests. See Appendix II for a classification chart and a reading on identification of metals.	See Appendix II-p. 32-33 (3) p. 18-24
II. Physical Properties of Metal	The student will be able to discuss the physical properties of metal as to its thermal conductivity, magnetism, thermal expansion, and cold working.	Discussion-demonstration. When given the required materials, tools, and equipment, the student will successfully complete four experiments: (1) thermal conductivity, (2) magnetic properties, (3) thermal expansion, and (4) cold working and annealing. In Appendix II there is a reading on the properties of metal, a list of supplies and equipment needed for the experiment, and a written form of the experiments.	See Appendix II-p. 34-42 (3) p. 18-24

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
III. Aluminum	The student will be able to explain how aluminum is produced, its alloys and outstanding qualities	Discussion-demonstration. Teacher may have students write a short paper on aluminum. See Appendix II for a reading on aluminum.	See Appendix II-p. 43 (3) p. 20
IV. Iron and Steel	The student will be able to do the following: (1) Discuss the production and working qualities of iron, steel, and steel alloyw (2) Explain the four or five digit coding system of SAE and ALSI (3) Discuss effect of alloying elements in alloy steels (4) Discuss heat treatment of steel	Discussion-demonstration. See Appendix II for reading entitled "SAE and ALSI System of Steel Classification".	See Appendix II-p. 44 (16) (3) p. 18-24
V. Lumber Technology	The student will be able to discuss the following things about lumber technology: (1) Characteristics of woods compared to other common materials such as metals, concrete, and plastics. (2) Forest conservation and significance of trees (3) Logging (4) Lumber manufacture (5) Manufacture of sheet products (6) Purchasing lumber	Discussion-demonstration. The students will do the following: (1) Compute area and board feet for dimension lumber and sheet material. (2) Construct a sample of plywood. (3) Press out hardboard and particle board samples. (4) Mount samples on display plaque, label, and place into notebook. See Appendix II for reading on "Lumber Technology". Supplies: Sawdust Wood chips Thermosetting adhesive (urea or resorcinol) Wood veneer Display plaque format of	See Appendix II-p. 45-47 (10) p. 78-188 (11) p. 1-79

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		heavy paper Felt tip pens White polyvinyl glue Equipment: Laminating press	
VI. Identification of Woods and Trees	The student will be able to explain the following things about identification of woods and trees: (1) Two main types of woods (2) Characteristics of trees and leaves which aid identification purposes (3) Specific identifying characteristics of (a) Hardwoods (open or close grain, color of heartwood and sap wood, design of grain pattern, density and hardness) (b) Softwoods	Discussion-demonstration. The student is to prepare, mount, and label four hardwoods and four softwoods on two heavy paper display plaques. These plaques will be placed in the student notebook. See Appendix II for reading on "Identification of Woods".	See Appendix II-p. 48-50 (10) p. 77-188 (11) p. 1-79
VII. Paper	The student will be able to discuss the following things about paper: (1) Its definition (2) Types of paper (3) How paper is made (a) Materials used (b) Processes of making paper (4) Conservation of paper (5) The process of making paper by hand	Discussion-demonstration. The students will make a piece of fine paper by hand. See Appendix II for more information on paper making.	See Appendix II-p. 51-53 (18) (4) Ch. 13
VIII. Industrial Paper	The student will be able to discuss the following things about industrial paper: (1) Its identification (2) Kinds (3) Examples of	Discussion-demonstration. The students will construct a 8" x 12" piece of paperboard by glueing together of liners and a corrugated center. It is to be used in the following lesson.	See Appendix II-p. 54-56

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	(4) The assembly of corrugated board	Supplies: Examples of industrial paper products Paper liner and corrugated paper White polyvinyl glue	See Appendix II-p. 57
IX. Industrial Paper Packaging	The student will be able to list the following steps for building a package from paperboard: (1) layout, (2) printing, (3) cutting, (4) scoring, (5) coating, and (6) folding.	Discussion-demonstration. Given the necessary tools, specifications, and a product to be packaged, the student will layout and cut out a box that fits the packaged article within 1/8 inch on all sides. Supplies: Tic-tac-toe package Paperboard Layout tools Razor blades Scissors Narrow roller (for scoring) Felt tip pens Coating system (pressurized can of clear acrylic finish) See Appendix II for student activity on construction of a package.	
X. Package Testing and Cost	The student will be able to explain the testing of a package and calculating its cost	Discussion-demonstration. The student will perform burst strength tests on paper and calculate the cost of the box constructed earlier. Supplies: Items to be tested Price lists for building Equipment: Pneumatic burst tester	See Appendix II-p. 57

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		(5) Given a list of ten materials, some organic and some inorganic, they will select four which are used as raw materials in the making of plastics materials. (6) Given a list of ten elements, they will identify four elements which are found in many plastics materials. (7) Draw a diagram of the elemental structure of a simple polymer.	
XIII. Identification of Plastics	The student will be able to do the following: (1) Explain the specific gravity test by submerging samples in water (2) Explain the series of solvents used by going through the series with several plastics samples (3) Demonstrate the heat test on thermoplastics and thermosets with a soldering gun (4) Show the burning characteristics of several plastics (5) Manipulate several plastics samples to show their brittleness, toughness, etc. (6) Explain the charting procedure (7) Explain the dangers of working with solvents and open flame (8) Demonstrate the entire identification procedure with an "unknown" sample, such as polystyrene and polyethylene (9) Check out plastics samples to the students	Discussion-demonstration. The student will observe the reaction of eight plastics samples as they are subjected to the specific gravity, solvent, heat, burn, and physical properties tests. They will also chart the results on a form provided to them. Supplies: Baby food jars for containing solvents Solvents - water, toluene, butyl acetate, acetone, and cyclohexanone Tweezers - fabricated from sheetmetal strips Plastics samples - styrene, ABS, acrylic, nylon, polyethylene, polyvinyl chloride, urethane foam, phenolic, and butyrate Equipment: Alcohol burners Electric soldering gun See Appendix II for (1) identification chart, (2) reading on identification procedure.	See Appendix II-p. 58-60 (20) p. 9-32 (17) Ch. 1, 2, 3 (7) Ch. 1-5

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
XI. Plastics	The students will be able to discuss the following things about plastics: (1) Plastics defined - a group of synthetic materials, composed of hydrocarbons having a high molecular weight, which flow at some stage in their development into products (2) Historical development of thermoplastics and thermosets (a) Thermoplastics (b) Thermosets (3) World War II developments (4) Present status (5) Unique characteristics of plastics as compared to non-plastics materials such as: wood, metals, stone, and ceramics (6) Unique characteristics of thermosets as compared to thermoplastics (7) Unique characteristics of thermoplastics as compared to thermosets (8) The working properties of thermoplastics and thermosets	Discussion-demonstration. The student will observe a teacher demonstration on the characteristics of thermoplastics (the polyvinyl worm) and thermosetting plastics (the polyurethane foam). If class time allows, the students will make a few worms and foam a small polyurethane sample. Supplies: Polyvinyl worm kit Disposable cups Tongue depressors for stirring Polyurethane foam, Components "A" and "B" Solvents, lacquer thinner, and cychlohexanone Equipment: Hot plate Soldering gun	(20) p. 9-32 (17) Ch. 1, 2, 3 (7) Ch. 1-5
XII. Composition of Plastics	The student will be able to explain the definition and historical aspects of plastics; also, the raw materials used in making plastics and the chemical composition essential to all plastics material manufacture.	Discussion-demonstration. The students will do the following: (1) Indicate orally the four elements which make up the definition of plastics materials. (2) Describe the thermoplastic characteristics. (3) Describe thermosetting plastics characteristics. (4) Describe orally the significance of the historical dates of 1868 and 1909.	(20) p. 9-32 (17) Ch. 1, 2, 3 (7) Ch. 1-5

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
XIV. Textiles and Fabric Construction	The student will be able to define the meaning of the following textile terms: (1) filaments, (2) monofilament, (3) multifilament, (4) staple fibers, (5)filament tow, (6) denier, (7) crimp, (8) weave, (9) knit, (10) yarn, (11) sizing, and (12) finish. The student will be able to describe the characteristics of and uses for textiles.	Discussion-demonstration. Students will cut cloth samples, mount them on a display plaque and label their characteristics. Supplies: Fabric remnants - felt; polyester double knit; muslin; crepe fiber glass; single, double, and woven roving weaves; burlap; and ticking Textile and fabric construction display plaque A variety of textile products Two inch square metal templates Scissors Steel rule die (optional) Equipment: Press for steel rule die See Appendix II for student activity on "Textiles and Fabric Construction" and a textile chart.	See Appendix II-p. 61-63 (9)
XV. Rubber	The student will be able to discuss the following things about rubber: (1) Definition of rubber - an organic material characterized by its high coefficient of friction, flexibility, elastomeric and dielectric qualities (2) Unique properties of rubber as compared to other materials, such as wood, metals, ceramics, and plastics (3) The development of rubber as an industrial material (a) Discovery of natural rubber	Discussion-demonstration. The student will take samples of different types of rubber, mount them on a display plaque, and label their characteristics. Supplies: Heavy poster board display plaque format Rubber cement Rubber samples with an area of 1½" x 1½" 1. Neoprene - open cell 2. Neoprene - close cell 3. Natural gum	(6)

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	(b) Development of synthetic rubbers	4. Silicone 5. Cold recap tread 6. Adhesive for cold recap 7. Hot recap rubber	
XVI. Rubber Tires	The student will be able to explain the prominence of rubber in transportation tires and the system of tire manufacture.	Discussion-demonstration. Student activity as follows: (1) The student will rough cut material, 1" x 4" and 2" x 4", for wood base of shoe. (2) The student will then laminate the two pieces together. (3) The student will rough cut rubber sole material to shape on bandsaw. (4) The student will cut vinyl upper material to rough shape with scissors using a metal template as a guide. Supplies: Two 1" x 4" x 12" and two 2" x 4" x 12" fir or spruce Wood clamps Glue Scissors Metal roughing template for supported vinyl Supported vinyl Equipment: Radial arm saw Band saw See Appendix II for information on the wooden clogs.	See Appendix II-p. 64-65 (21)

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
XVII. Materials with Rubberlike Characteristics	The student will be able to discuss the elastomeric qualities of leather and supported vinyl	Discussion-demonstration. The student will hand sand the wooden clog body to a smooth surface, apply a finish, and tailor the supported vinyl upper of the clog. Supplies: Abrasive papers Finish (fash drying, hand applied, i.e. Deft) Brush Supported vinyl Metal templates Scissors	(6)
XVIII. Recapping Tires	The student will be able to explain the procedure of recapping. (1) Processes (a) Hot recapping (b) Cold recapping	Discussion-demonstration. The students will recite the names and description of the two recapping processes and they will continue working on clogs. The wooden body will be sculptured and the rubber tread will be adhered. Supplies: Wood laminations Contact cement Brush Recap tread, 10/32" (See Appendix B, Lesson 33 for vendor) Equipment: Band Saw Disc sander Drum sander or drill press	(6)
XIX. Vulcanizing Rubber	The student will be able to do the following: (1) Define vulcanization (2) Discuss the need for sulfur (3) Describe the process of vulcanization	Discussion-demonstration. The student will observe a demonstration of rubber vulcanization and will assemble the supported vinyl upper to the clog base.	(6)

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	(a) Load raw rubber into a metal mold (b) Apply pressure and heat for a specified amount of time (c) Cool mold and remove vulcanized part	Supplies: Tacks Hot recap rubber (See Appendix B, Lesson 34 for vendor) Supported vinyl (tailored) Metal mold for rubber vulcanization Equipment: Laminating press with heated platens	
XX. Rock and Stone	The student will be able to define the following: (1) Rock - a concretion of earthy or mineral matter of inorganic composition (2) Stone - small weathered rock fragments or those portions of rocks which are shaped for buildings The student will be able to identify the stones: granite, sandstone, limestone, shale, slate, and marble. He will also be able to discuss their properties.	Discussion-demonstration. The student will produce a stone identification plaque which includes six stones and a listing of their characteristics. The stones will be packaged in place with a clear acetate blister. Supplies: One stone of each kind: Sandstone Slate Granite Marble Limestone Shale Clear acetate for the blister package Heavy paper plaque format Equipment: Chipping hammers Tumbler Sandblaster See Appendix II for example of "Rock Identification Plaque" and a reading on "Rock and Stone".	See Appendix II-p. 66-69
XXI. Ceramics	The student will be able to discuss the following: (1) Definition of clay (2) Unique properties of ceramics	Discussion-demonstration. Student activities are as follows: (1) The student will differentiate the terms "clay" and "ceramic".	(5)

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	(3) Industrial uses of ceramics (4) Types of clay (5) Firing	(2) The student will identify in writing the names of at least six ceramic products. (3) The student will describe the unique properties of ceramic materials as compared to other materials such as metals, plastics, woods, and rubbers. (4) The student will match the names of at least three types of clays with a description of their common uses.	
XXII. Glass	The student will be able to discuss the following things about glass: (1) Definition of glass (2) Materials used to make glass (3) Properties of various types of glasses such as: quartz, soda-lime glass, and borosilicate glass (4) Glass processing methods (5) Procedure of cutting glass	Discussion-demonstration. Student activities are as follows: (1) The student will identify at least six of the ten chemicals used in glass. (2) The student will choose the correct definition of glass from a list of four alternatives. (3) The student will match the descriptions of glasses with their corresponding names for the following three types: (a) quartz, (b) soda-lime glass, and (c) borosilicate glass. (4) Given only two attempts, the student will cut a piece of glass by using a glass cutter and steel rod. (5) The student will recall orally the sequential steps required to form glass. Supplies: 3/32" lime glass Glass cutter Abrasive paper Variety of glass products See Appendix II for a reading on glass.	See Appendix II-p. 70-71

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
XXIII. Cement and Concrete	The student will be able to define Portland cement and discuss the following things about it: (1) Properties (2) How Portland cement is made (3) Types of Portland cement The student will be able to define concrete and discuss the following things about it: (1) How concrete becomes "cured" (2) How to determine the strength of concrete	Discussion-demonstration. Students are to separate mixed aggregate by using 1/4", 1/2" and 3/4" riddles into fine and coarse aggregate. Supplies: Mixed aggregate 1/4" riddle 1/2" riddle 3/4" riddle Canvas tarpaulin (optional) 5 gallon buckets for aggregate storage Pictures of concrete products (optional)	(8) p. 25-79
XXIV. Mixing and Testing Concrete	The student will be able to discuss the following things about processing concrete: (1) Designing the concrete mix (2) Testing the concrete mix (3) Forming concrete into test specimens (4) Curing concrete (5) Testing cured concrete	Discussion-demonstration. Students will mix concrete and slump test the mix. Also, they will cast four test beams with various reinforcement and two test cylinders from concrete used in the slump test. Supplies: Water Sand Aggregate Cement Slump test form 4 test beam molds 2 test cylinder molds 3/8" reinforcement steel bar Equipment: Concrete mixing equipment	(8) p. 25-79
XXV. Concrete Reinforcement	The student will be able to identify the following types of reinforcements: (1) Bars (2) Welded wire mesh The student will be able to explain the care and installation of reinforcing materials.	Discussion-demonstration.	(8) p. 25-79

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
XXVI. Plasters	The student will be able to discuss the following things about plaster: (1) Definition (2) Properties of cured plaster (3) Mixing procedures (4) Shaping plaster (5) Parting agents required on porous surfaces (6) Major types of plaster (7) Major uses for plaster	Discussion-demonstration. After observing the instructor taking a plaster splash, the student will prepare a small wood and clay pattern. A plaster splash will be taken from the pattern on a later date. See Appendix II for a small wood and clay pattern.	See Appendix II-p. 72 (12)
XXVII. Plaster Pattern Making	The student will be able to explain the following things about plaster pattern making: (1) Parting agent for porous surface (2) Mixing plaster (3) Taking a plaster splash	Discussion-demonstration. Students will complete wood-clay pattern and will take a plaster splash of same. The splash will be used as a foundry pattern in a later lesson. Supplies: Plastic containers White plaster Hydrocal plaster Hemp Shellac Alcohol Lacquer 2" shellac brush Petroleum jelly Masking tape Modeling clay 3/4" x 10" x 10" fir plywood for pattern base Wiping rags Equipment: Water sink with plaster trap Spray booth and spray gun Pneumatic drill motor for stirring plaster	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
Unit III - Forming Materials	The student will be able to explain the four concepts of shaping: (a) forming, (b) separating, (c) combining, and (d) finishing. The student will be able to discuss the following types of forming: (1) Casting and molding - the materials generally liquefy or become semi-liquid during casting and molding (a) Cold casting materials - casting materials that are liquid at room temperatures and harden in room temperatures - gravity is sufficient pressure (b) Hot casting materials - casting materials which liquefy when heated and harden in room temperatures - gravity is sufficient pressure (c) Molding - forming materials with pressures higher than gravity in matched molds or dies usually made of metal (2) Compressing and stretching - forming materials (solids, sheets, or bars) at room or elevated temperatures. Both compressing and stretching occur simultaneously in most operations	Discussion-demonstration. The student will become familiar with the products that will be manufactured in this unit by observing the product and pictures of production sequences.	(13) p. 112-144
I. Stretch Forming	The student will be able to discuss the principles and common materials used in the stretch forming process. The student will be able to describe:	Discussion-demonstration. The student will produce the stretch forming tool and will complete the entire stretch formed fruit bowl prior to engaging in any other laboratory activity.	(13) p. 187-204

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	(a) stretch forming sheet metal, and (b) stretch forming textiles	Supplies: Sketching paper 3/4" x 8" x 10" wood Polyester double knit cloth with good drapability Carpet tacks Tack hammers Scissors Sandpaper Paste wax Polyester resin with catalyst 1" inexpensive stain brushes Lacquer thinner White polyvinyl glue Disposable cups ½" x 3" wooden dowel Equipment: Band saw Drill press Disc sander	
II. Rotational and Blow Molding	The student will be able to explain the following: (1) Rotational molding - molding completely closed hollow objects of plastics and rubber by rotating raw materials inside a heated mold (2) Blow molding - molding hollow objects by blowing a heated tube (parison) of plastics or glass against the walls of a two-piece female mold	Discussion-demonstration. After having observed demonstrations, students will form a wax fruit and polyethylene bottle by rotational molding and blow molding respectively. Supplies: Candle wax with dyes Petroleum jelly parting agent 3/4" OD polyethylene tubing Fruit molds Blow molding device Equipment: Air compressor Oven Rotational molder (optional)	(13) p. 560-561

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
III. Drape Forming Reinforced Plastics	The student will be able to discuss the following: (1) Principles of reinforced plastics (2) Systems for forming reinforced plastics (3) Characteristics of reinforced plastics	Discussion-demonstration. Student activities are as follows: (1) Given four descriptions the student will select an appropriate definition of reinforced plastics. (2) The student will describe the characteristics of reinforced plastics products. (3) The student will match description of processing methods with corresponding names. (4) Given the necessary tools and supplies the student will produce a model boat hull comprised of two layers. Supplies: Boat hull mold Fiber glass cloth Polyester resin with catalyst 1" stain brushes Polyester dyes Paste wax Wiping rags Scissors Lacquer thinner Weighing scales Disposable cups and stirring sticks Equipment: Circular saw or drill press horizontal saw	(17) p. 50, 88-94, 191-198 (7) p. 14, 27, 39
IV. Thermoforming Thermoplastics	The student will be able to explain the following: (1) Thermoforming - forming thermoplastic sheet stock by heating until plasticized and forcing (vacuum or compressed air) against	Discussion-demonstration. The student will thermoform a model boat deck of styrene plastics sheet. Supplies: .040" - .060" styrene sheet Thermoforming male mold	(7) p. 12-14, 40, 138, 271 (17) p. 82-94, 140-156

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	a form until cold. (a) Processing methods: vacuum seal, cavity vacuum, ramming using male and female mole (b) Nature of thermoformed parts	Sheet clamping frame of wood Equipment: Vacuum forming table Drill press with horizontal circular saw	
V. Casting Metals	The student will be able to discuss the following things about foundry practice: (1) Hot casting (2) Patterns (3) Types of molds (4) Pouring procedures	Discussion-demonstration. The student will cast a model boat dagger board of aluminum with a match plate and green sand. Supplies: Match plate pattern Green foundry sand Flasks Ramming tools Aluminum ingots Hack saw Curved tooth files 1/2" twist drill Crucible Safety clothing Tongs Pyrometer Flux Skimming tools Equipment: Drill press Foundry furnace	(13) p. 112-121
VI. Foaming Cellular Plastics	The student will be able to explain the following: (1) Cellular molding (2) Purpose and process of foaming cellular materials (3) Expanded polystyrene (4) Foaming urethane	Discussion-demonstration. Floatation and adhesion qualities of urethane resin will be shown as students assemble the model boat hull, deck, and dagger board. Supplies: Boat hull, deck, and dagger board Urethane foam components Disposable cups	(17) p. 95-97, 177-183

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		Stirring sticks Weighing scales Alcohol for cleaning	
VII. Forging Metals	The student will be able to define forging and discuss the following: (1) Characteristics of a forged part (2) Systems of forging (3) Forged products	Discussion-demonstration. The student will forge a screwdriver blade with a drop forge and properly temper the screwdriver blade by observing the temper colors. Supplies: 1/4" medium carbon drill rod Abrasive cloth Hacksaw Tongs Asbestos gloves Match plate for handle Aluminum ingot Vinyl coating (optional) Curved tooth files Equipment: Gas fired forge Drop forge Pedestal grinder	(13) p. 151-159
VIII. EXPLOSIVE FORMING	The student will be able to discuss the value of an explosive charge in forming metal.	Discussion.	(13) p. 184-185
IX. Metal Spinning and Stamping	The student will be able to explain the process of metal spinning and stamping.	Discussion-demonstration. The student will stamp and spin an aluminum coaster. Supplies: .030" - .050" 1100 series annealed aluminum Forming chuck and follow block for spinning Round nose spinning tool Cutoff tool for spinning Form blocks for metal stamping	(13) p. 171-177

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		Beeswax for lubrication Abrasive cloth Equipment: Hydraulic press Wood lathe	
X. Contour Lamination	The student will be able to explain the properties and processes of contour lamination with woods. The student will be able to define: (a) Contour lamination - pressing wood layers, with adhesive between the layers, to desired shape with matching male/female forms until the adhesive has cured	Discussion-demonstration. The student will make a salad fork by the contour laminating process. Supplies: Veneer White vinyl glue Wax paper Glue brushes Matching wooden molds Abrasive paper Finishing oil Hand screw clamps Files Equipment: Band saw Jig saw	(10) p. 372-382 (11) p. 51
XI. Casting and Forming Imitation Glass	The student will be able to discuss the following: (1) The difficulties of glass forming and coloring (2) The development of polyester and acrylic glass synthetics	Discussion-demonstration. The student will form acrylic by draping over a male form and will cast a synthetic stained glass window of polyester. Supplies: 1/10" - 1/8" clear acrylic sheet Drape forming tool Polyester resin with catalyst Stained glass window molds Aluminum filled epoxy Parting agents Equipment: Oven Band saw	

COURSE: MATERIALS AND PROCESSES

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
XII. Casting Plaster	The student will be able to discuss the properties of cured plaster and procedures for processing it into desired shapes.	Discussion-demonstration. The students will make a white plaster mold, for casting chessmen of slip clay, by casting against a chessmen master tool. Supplies: White plaster Mold masters Petroleum jelly Plastic mixing containers Pneumatic mechanical mixer Old wood chisels Putty knives for clean-up Equipment: Water sink with plaster trap	(13) p. 141-142
XIII. Casting Slip Clay	The student will be able to discuss the following: (1) Methods of clay forming (2) Slip casting (3) How to turn clay into a ceramic	Discussion-demonstration. The student will make chessmen by the slip casting procedure. Supplies: White plaster molds Slip clay Dump buckets Trimming knives Equipment: Ceramic kiln Ventilated storage shelving	(22) p. 248
XIV. Injection Molding	The student will be able to explain the process of injection molding.	Discussion-demonstration. The student will injection mold polystyrene checkers, if equipment is available. Supplies: Red and black polystyrene pellets Silicone parting agent Gate cutters Small file Checker injection mold Equipment: Injection molding machine	(13) p. 557-560 (17) p. 66-85

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
Unit IV - Separating Materials	The student will be able to discuss how materials are shaped by forming, separating, combining, and finishing. The student will be able to discuss the following things about the separating process: (1) Separating primary materials - materials much like they are found in nature; these materials have had little or no industrial processing (2) Separating secondary materials - those materials which have been industrially processed into standard stock	Discussion-demonstration. Student activities are as follows: (1) The student will match descriptions of separating processes with the corresponding process name. (2) The student will recall the descriptions of primary and secondary materials. (3) The student will indicate at least four types of separation, both from primary and secondary materials. (4) The student will become familiar with products manufactured in this unit by observing the product and pictures of manufacturing sequences. Supplies: Chess cabinet, including polystyrene foam liner, checkerboard, and laminate lid Printed circuit board for optical lamp Permanent casting mold (produced by machining an aluminum casting)	(13)
I. Millwork: Woods	The student will be able to explain the following operations done of millwork: (1) cutting, (2) surfacing, (3) joinery, and (4) smoothing. The student will be able to discuss the woodworking tools and machines used for millwork.	Discussion-demonstration. The student will do the millwork required to manufacture a wooden chess cabinet according to specifications. Supplies: Sample wood for demonstration of cuts Dado blades (for rabbet joints and dado) 1" x 9" rough stock - Philippine mahogany Sandpaper Bar clamps	(11) p. 129, 180, 192 (10) p. 221, 284, 313 See Appendix II-p. 85-87

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		White polyvinyl glue Glue brushes ½" fir plywood Linseed oil for finishing Claw hammers 3 penny finish nails Nail set Equipment: Jointer Router Surfacer Circular saw Radial arm saw Belt sanders Vibrating sanders See Appendix III for additional information on the construction of the chess cabinet.	
II. Thermal Cutting	The student will be able to define thermal separating and its following process: (1) Hot wire (2) Oxy-acetylene cutting (3) Arc cutting	Discussion-demonstration. The student will cut polystyrene foam to chess cabinet size. The student will also be given a chance to cut through plate steel with an oxy-acetylene cutting torch. Supplies: Cellular polystyrene foam liner 3/8" steel plate Equipment: Hot wire cutter Oxy-acetylene outfit with cutting attachments V8 E6011 electrode or special arc cutting electrode (optional)	(17) p. 25, 26, 97 (3) p. 3, 9

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		225 ampere arc welding machine (optional) Proper number of goggles and helmets	
III. Shearing and Induced Fracture	The student will be able to discuss the shearing method of separating materials and its applications.	Discussion-demonstration. The student will shear plastics sheet to required size and quantity for the checker board. Supplies: Variety of hand shears .060" ABS sheet (white and black colors) Bottle cutting machine Bottles Equipment: Squaring shears Floor shears Curved shears Notching shears See Appendix III for information on "Checkerboard Construction".	(13) p. 446 (17) p. 102 See Appendix III-p. 88
IV. Machining	The student will be able to discuss the following things: (1) Definition of machining (2) Characteristics of machine parts (3) Basic types of machining (a) Drilling (b) Turning (c) Milling (d) Shaping (e) Grinding	Discussion-demonstration. A permanent aluminum mold, designed for casting a lead paperweight, will be machined from a casting and a 1/4" plate. Supplies: 1/4" aluminum plate Aluminum casting (made from a plaster pattern constructed earlier) End mill cutters Single point fly cutters 5/6" twist drill Hold down clamps for mill Mill files	(13) p. 308, 319, 343, 389

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		Equipment: Vertical milling machine Drill press Band saw	
V. Cutting with Abrasives	The student will be able to define the term: abrasive. The student will be able to discuss the following types of abrasive materials: (1) Diamond (2) Silicone carbide (3) Aluminum (4) Flint (5) Garnet (6) Emery cloth (7) Steel wool (8) Pumice stone (9) Crocus cloth	Discussion-demonstration. The student will construct and trim the chess cabinet lid. Supplies: Decorative laminate with wood grain pattern Contact cement 1/4" tempered masonite 8" - 10" abrasive cutoff wheel Abrasive paper Cement brush Lathe bit Abrasive saw blade Equipment: Circular table saw Pedestal grinder See Appendix III for procedure of the construction of chess cabinet lid.	(13) p. 391-399 See Appendix III-p. 89
VI. Chemical and Electrical Etching	The student will be able to explain the following things: (1) Definition of etching (a) Reasons for etching (b) Types of etching (2) Printed circuitry (a) Physical properties required for printed circuit materials (b) Electrical circuit history (c) Composition of printed circuit boards	Discussion-demonstration. The student will produce a printed circuit board by chemical etching for the optical lamp. Supplies: Developer solution Etching solution Stripping solution 3 1/4" x 6" pre-sensitized circuit boards Metal trays Plastic trays Contact frames Negatives Exposer light or sunlight	(15)

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
Unit V - Combining Materials	The student will be able to discuss the following things about combining materials: (1) Its purpose and types (2) Combining or mixing ingredients (3) Fastening systems for solids (4) Mechanical fasteners	Discussion-demonstration. The student will become familiar with the products that will be produced in this unit by handling the products and observing pictures of manufacturing sequences. Producing products by combining materials - student activities to be completed in this unit are: (1) Adhesion, cohesion, and mechanical fasteners - metals fastening systems display (2) Adhesion, cohesion, and mechanical fasteners - covered wagon made of wood (3) Mechanical fastening of textiles - cloth back pack (4) Tying rope knots - display plaque (5) Mixing ingredients - call attention to plaster, clay, and concrete products produced earlier (6) Soldering components - printed circuit board See Appendix IV for student activity lessons and reading on combining materials. *The completion of this unit will take several days.	(1)

COURSE: MATERIALS AND PROCESSES

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
Unit VI - Finishing Materials	The student will be able to discuss the following things about finishing: (1) Finishing by forming - obtaining a desired surface texture through pressure (a) Embossing (b) Molding (c) Knurling (2) Finishing by separating - obtaining a desired surface texture by removing material (a) Machining (b) Sanding and grinding (c) Buffing and polishing (3) Finishing by combining - adding materials, generally called finishes, to other materials is a finishing process required on materials not having the desired color or inherent lasting qualities. Mild steel must be coated to prevent corrosion and when a color other than gray is desired. (a) Types of coating materials (b) Characteristics of coating materials (c) Systems for applying coatings (4) Finishing systems unique to specific materials and products (a) Concrete and plaster (b) Paper (c) Timber woods (d) Cabinet woods (e) Textiles (f) Metal anodizing (g) Vacuum metallizing	Discussion-demonstration. Student activities are as follows: (1) The student will finish metals by forming, separating, and combining processes. (2) The student will finish woods materials by separating and combining processes. (3) The student will finish ceramics by combining processes. (4) A "Finishing Systems for Metals" display plaque will be produced by each student. (5) Three wooden picture frames will be finished by each student. (6) The entire set of chessmen will be finished by each student. Readings: "The Purpose and Procedure for Finishing Metals" "Sandpaper Abrasives" "Coatings for Cabinet Woods" Supplies: Completed products for display purposes 1. "Finishing System for Metals" display plaque 2. Finished picture frames 3. Finished chessmen See Appendix V for reading and activity lessons on finishing materials. *This unit will take several days for completion.	See Appendix V-p. 109-125

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
Unit VII - Development of Products	The student will be able to discuss how products are designed and built.	Discussion-demonstration. The students will be shown the "Engineering Format (Design Procedure)" and will develop products from the ideas given by the instructor or some of his own. Students will use the "Design Analysis Chart" to insure that all design phases are included in product development. Students will proceed according to the design procedure, marking off each phase as it is completed. The instructor should go over each phase with the students. Students will present the following items to the instructor: (1) Completed "Design Analysis Chart" (2) Preliminary sketches and data (3) Refined sketches and data (4) Models (5) Final design drawings and data (6) Completed products Instructor's activities are as follows: (1) Instructor should hand out and discuss the thirteen phases in the engineering procedure that are followed in designing a product. (2) Instructor should hand out and discuss the design analysis chart. (3) Hand out laboratory activity sheet. Discuss the project with students. (This is Phase I of the Engineering Format).	See Appendix IV- p. 128-139

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		(4) Divide students into groups of five for role playing activities. These groups should contain representatives of management, engineers, and clientele Reading: "Engineering Format (Design Procedure)" "Designing a Product" Supplies: Paper Pencils Resource library Necessary materials and tools to build mock-ups, prototypes, and products See Appendix VI for readings and student activity lessons of "Development of Products".	

LEARNING ACTIVITIES:

The ultimate success of any program centers in the quality of the instruction that takes place. Central to this success is the quality of the teaching and learning activities that are used in meeting stated objectives.

Industrial education programs have always focused on the laboratory approach of "Learning by doing." The ideas for teachers and the learning activities for students that are included in this handbook were selected as exemplary learning experiences.

Industrial education programs should be exciting, relevant and action oriented. Well designed activities, selected from a variety of sources, that motivate students are included as suggestions for improving instruction.

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The following material illustrates how Westfield High School has adapted curriculum to provide students with a broad introduction to materials and processes.

For additional information contact:

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COURSE CONTENT

The materials and processes course at Westfield is designed to present a broad introduction to the techniques that man has developed to change raw materials into a more usable form of a finished product.

The following objectives are identified as the specific learning that should take place during the first 14 weeks of the station-to station activities.

1. The student will: work with individualized instruction to prepare him/her for further student directed learning.
2. Become aware of how to change materials by any one or a combination of combining, separating, conditioning, and/or forming processes.
3. Use machines and tools correctly.
4. Develop basic skills in the processing of materials.
5. Develop problem solving abilities
6. Become aware of careers in the materials and processes field
7. Develop basic knowledge of materials and how to process them.
8. Develop safe working habits
9. Understand the interaction of industry and society.
10. Experience new industrial processes and explain how and why man changes raw materials into a usable commodity.

Time	Machine		Activity
Week 1	None	Orientation:	a. What is M & P b. Safety c. Job attitude d. Classification of materials e. Processing of materials 1. Forming 2. Conditioning 3. Separating 4. Combining

Week 2	As needed	Demonstrate each machine as the students will use it from station to station a. safety b. machine procedure c. project to be made d. how to use the self instructional project e. grading of the project
Week 3 thru 15	As needed	Station to station

The station to station rotation is an activity designed to give the student a broad exposure to all machines and materials used in the materials and processes shop. The student will experience a process at each station using self instructional material prepared for that station. This self instructional material allows the student to progress at his or her own rate and advance as far as capabilities and time allows. The material at each station is carefully prepared to give the student a wide variety of experiences and progress safely. To further aid the student a resource center is centrally located and is equipped with film loops, slide series, film strips, and text books that can further illustrate the station when help is needed.

STATION TO STATION

STATION	LOCATION	ACTIVITY
1	Surfacer, jointer Bench saw	Square up a block of wood to tolerance Size 3/4 x 2 1/2 x 7 5/8
2	Block plane	Chamfer the block from Station 1
3	Finishing room	Sand, stain, and varnish the block from Stations 1&2 (Note-this block will become the base to the napkin holder in Station 8.)
4	Foundry	Ram up and cast a simple aluminum casting
5	Tool room	Check out tools, (during this time the student may clean up the foundry casting)
6	Arc welding	Strike a bead and weld two pieces of steel together
7	Oxyacetelyene welding	Puddeling, weld two pieces of steel together

STATION	LOCATION	ACTIVITY
8	Sheet metal layout & bending	Make a paper pattern and then a metal napkin holder
9	Soldering Pop riveting Spot weld	Solder two pieces of sheet metal together Pop rivet two pieces of sheet metal together Spot weld two pieces of sheet metal together
10	Milling machine	Machine the surface of a block of aluminum
11	Measuring	Reading the micrometer Reading the vernier calipers
12	Machine lathe	Turn a round shaft to tolerance + - ,003
13	Plastics	Thermo-form a desk caddy Injection mold a golf tee Injection mold a screw driver handle
14	Plastics	Make a Plastisol coin purse Make a plastic ball, rotational molding
15	Wood Lathe	Turn a baseball bat,(note-this activity will be done by a series of students)
16	Heat Treating Forming & Conditioning	Form and condition a screw driver blade
17	Plastic casting	Cast an E-A cast handle for the screw driver blade
18	Universal testing Machine	Perform some basic testing functions of material
19	Independent Study	Term paper/oral report/or visit to an industry to explore a new industrial process or material.

Each student is required to achieve a minimum of 14 successful activities for a grade. A student not completing this by the end of allotted time for the station to station may go back to complete the work or redo it satisfactorily. Students who complete 14 stations may then proceed to the required projects.

Week 16-17-18 Complete any stations not completed.
Students who have completed all required stations may start to work on the required projects or contract to do more work at any one process.

ACTIVITIES

This grouping of activities is a composite selection of many different sources. There intended purpose is to give the instructor meaningful hands on activities, plus some general ideas for formulation of new activites to be used with content areas.

Credits for all activities can be found in the resource section of this guide.

MATERIAL IDENTIFICATION

I - IV - 8

LEVEL I - American Industry
UNIT IV - Operating an Enterprise
Lesson 8 - Industry Uses a Variety of Materials
Student Activity Assignment Sheet #1

Name____________________
Date____________________

101 MATERIALS

Industry uses various materials in production. Many of the materials which you can identify in your immediate surroundings were not even discovered until after you were of school age. Many better materials will be discovered before you finish school. You cannot hope to be familiar with all of them. It would be a hopeless and never-ending task. However, you should have at least a passing acquaintance with a few of the common materials now used in industry. So let's identify some common materials. Let's identify 101 common materials in a car.

101 COMMON MATERIALS

Several hundred materials go into the production of a car. You are going to identify 101 of those materials. You will find this interesting, challenging, and hopefully enlightening. You might start by looking in the enclyclopedia. Looking under the term automobile will get you started. However, you will get names faster if you break the car into parts and look for the parts. For example, look for tire, air (in tire), oil products, gas, battery, generator, spark plugs, seat covers, car paint, etc. You will quickly discover that finding 101 materials is not so difficult as you might have first imagined. Neatly number and list the materials on notebook paper and attach to the back of this activity sheet.

Grade___________

I - IV - 8

IS YOUR LIST CONFUSING?

You have discovered by now that there seems to be no end to the number of materials that we could find and identify. You might just as well have been asked to identify 1001 materials used in industry. If we are to work with all of these materials, we must have some easy way of organizing them besides just listing them as you have been asked to do. Take a good look at your list. You have solids, gases, liquids, woods, stones, elements, compounds, etc., all mixed in one list. It is much easier to work with materials and understand them if we put them in some logical categories. Your instructor has given you one way you might categorize materials. To make your list of 101 materials more meaningful, neatly list the materials under an appropriate material category on notebook paper and attach to the back of this activity assignment sheet.

Grade__________

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MATERIAL IDENTIFICATION

Activity No.____________________ Name_________________________

Period_________________________

Industrial-Consumer Products

Directions: Choose one of the products listed below - or any simple product you have at home. Make a short list of the functions (what it does), and the characteristics of the material it is made from.

- Candle
- Wooden Spoon
- Sugar
- Window Glass
- Mother's Apron
- Others
- Newspaper
- Candy Bar
- Soap (bar)
- Cake Pan
- Cake

The Problem is to:

List the natural materials used to make each product.

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MATERIALS CHARACTERISTICS

LEVEL I - American Industry
UNIT IV - Operating an Enterprise
Lesson 9 - Materials Have Many Characteristics (2 periods)

Stout State University
Summer, 1967

I. Objectives: At the conclusion of this lesson the student should be able to:

Identify salien characteristics of materials found in the American Industry lab and used by local enterprises.

II. Scope

Estehtic, mechanical, electrical, optical, lubricating, protective and cost characteristics of materials are discussed.

III. Resources

A. Instructional media

1. Duplicate activity sheets.

2. Assemble sets of materials to be tested in the activity. Have the temperature test done at one station.

3. Collect the following set of materials for the lesson: Wood, plastic sheet, sheet metal, solder, steel rod, glass tube, glass (sheet), fabrics, paper, rubber (two balloons), modeling clay, sugar lumps (cut into small pieces), oil, grease, water, paint, ink, turpentine, cheese, cement block, three bricks, and asbestos.

4. Propane torch or similar heat source.

B. Literature

1. Industrial Design Journal

2. Materials in Design Engineering Journal

3. Materials Engineering Journal

IV. Content Outline

A. Introduction

1. In the last lesson, we discussed the importance of materials in industry.
    a. All goods are made from materials.
    b. Most services require materials.
2. We found that materials can be solids, liquids, or gases.
3. We also learned that materials can be natural or manmade.

B. Activity and content

1. Today we are going to look at some other properties of materials.
2. First, let us list the properties which make materials decorative and pleasing to our senses. (Use appropriate samples of materials from your set of materials to bring out the following properties:)
    a. Color.
    b. Pattern.
    c. Texture.
    d. Taste (Give each student a samll sample of sugar and cheese.)
    e. Smell (Have your students sniff a sample of turpentine.)
    f. Would Pronto Pre-fabs be interested in any of these properties? (Discuss)
    g. Were these materials properties considered in our student enterprise in Unit I?

3. Industry also needs materials which can support heavy loads and withstand stresses. (Use appropriate samples of materials from your set of materials to demonstrate the following properties:)

   a. Elastic (Ability to retain original shape under stress. Twist, pull, flex, and place a load on material samples to show this.)

   b. Plastic (Changes shape with force and pressure. Blow up one of the balloons.)

   c. These are some of the mechanical properties of materials.

4. In the last unit, we discussed how energy was transferred from place to place through materials which conduct electricity readily. (Test the conductivity and dielectric qualities of some of the materials with a multimeter.)

5. For some purposes, it is necessary to consider the transparency of materials. Car windows have to admit light and give a clear view. Camera lenses must transmit light without distortion. (Show materials which transmit light.)

6. In some situations, materials are needed which are not transparent. These materials are opaque. (Show opaque materials and discuss when this characteristic is important.)

7. (Hand two different materials of equal size but different density to one of your students.) What property do you notice in these two materials? (Weight difference.) What causes this? (Difference in density.)

   a. Can this be an important property? (Note how aluminum parts are used in cars and the search for light-weight materials for aircraft.)

8. In the last unit, we discussed the maintenance of equipment in the property concept. At that time we found that certain materials have lubricating qualities. (Have one or two of your students rub their fingers on a metal plate under the following conditions: Dry and with the following as lubricants--oil, grease, water, turpentine, and clay. Ask them under which conditions their fingers slip over the metal with the least force.)

9. What are some of the reactions of materials to temperature changes? (Demonstrate with a heat source that some materials become pliable, others hot, some burn, some melt, and others are relatively unaffected.)

10. What is another property of materials which is important to a successful business? (Give them enough hints to elect "cost" as the correct response.)

    a. What happens as the cost of materials used to make a product increase?

    b. What influence would increased materials costs have had on the success of our enterprise in Unit I?

C. Application

1. We have just seen that many materials are used by industry. Now, I want you to name some of the materials used by local enterprises. (Record these on the board. Leave room on the right to list the major characteristics of each material.)

2. Why do these enterprises use these materials? What is the most important characteristic of each material? (List these on the right of your original list.

D. Summary

1. In this lesson, we discovered that materials have many characteristics. (Briefly review these characteristics: Aesthetic, mechanical, electrical, transparency, density, lubrication, reactions to temperature, and cost.)

2. (Assign the materials testing activity that follows. Provide enough materials so that your students can work without getting in each other's way. Select solids, liquids, and gases.)

V. Evaluation

A. You can include the listing of characteristics in the object test given for the last lesson if you are going to evaluate both lessons at the same time.

B. Using actual samples of materials (not the same samples used in the activity), have the student identify the aesthetic and mechanical characteristics of each sample.

LEVEL I - American Industry
UNIT IV - Organizing an Enterprise
Lesson 9 - Materials Have Many Characteristics
Student Activity Assignment Sheet #1

Name____________________
Date____________________

CHARACTERISTICS OF MATERIALS

Directions: Perform the tests listed below. Record your answers on these sheets. You will find a set of materials at each station where you will perform the tests given below. Write the name of each material above one of the columns drawn below.

PROPERTY AND TEST	MATERIALS 1	2	3	4	5	6
1. Aesthetic						
A. What color is the material?						
B. Does it have a pattern?						
C. What texture does it have?						
D. Is the material pleasing to look at?						
E. Is the material pleasing to touch?						

	1	2	3	4	5	6
2. Mechanical						
A. Can you twist the material out of shape?						
B. Can you flex the material?						
C. Can you rip the material?						
D. Can you bend the material?						
E. How much force is required to change the shape of the material?						
3. Transparency						
Can you see through the material?						

	1	2	3	4	5	6
4. How heavy is the material? Circle the heaviest material.						
5. Lubrication Place yes under the materials which have lubricating qualities.						
6. Temperature Heat the material as directed by your instructor. A. What happens when you heat the material? Be careful not to burn yourself!						

	1	2	3	4	5	6
7. Protective qualities Could they be used to help preserve other materials? How?						
8. Cost What is the cost of the material?						

MATERIAL SELECTION

LEVEL I - American Industry
UNIT IV - Operating an Enterprise
Lesson 10 - Materials Are Selected For Fulfilling Specific Needs (2 periods)

Stout State University
Summer, 1967

I. Objectives: At the conclusion of this lesson the student should be able to:

State that materials are selected to meet specific needs. In addition, he will be able to select materials to meet needs defined in the American Industry lab.

II. Scope

The previous lesson developed a basic knowledge of selected characteristics of materials. This lesson builds on these knowledges to make the student aware that materials characteristics have to be matched with product needs. The research skills learned in the last unit are reapplied in this lesson to give a systematic procedure for matching materials with product needs.

III. Resources

A. Instructional media

1. Select a film which depicts the development of materials to satisfy industry's needs.

2. Sample materials and test apparatus.

B. Literature

1. A materials handbook.

2. Reference books and pamphlets on various materials and their characteristics.

3. Catalogs which give current prices of materials.

IV. Content Outline

A. Introduction

1. In the last lesson, we discovered that materials have many characteristics. Some are solids, some are liquids, and some are gases. Can you think of any other characteristics?

2. How do you think the characteristics of materials are connected with their uses? (Goods and services require materials in their production. The materials used must supply characteristics which make it possible for the good or service to fulfill a consumer need.

3. In many instances, industry has developed materials to meet special needs. Alloys, such as various types of steels, are made to meet the stresses and demands placed on modern tools and machines. Plastics and synthetic fibers such as rayon and nylon are other examples of man's efforts to develop materials for his needs.

B. Activity and content

1. (Use option a or b below to demonstrate that materials are manufactured to have specific qualities.)

    a. (Show a film. Preview, introduce, and summarize so the film brings out the above noted points.)

    b. (Have a set of materials. This set should have the following attributes: solid, liquid, gas, natural, manmade, alloys, and composites such as plywood and woven fabrics. Use this set to develop the points noted in 1 above.)

2. We see that materials are often modified and designed to meet certain needs. How can we select the best material to use in our products here in class?

3. Actually, we can use the procedures we learned in research to help us here. Just as we defined our research problem, we can define the need a material has to satisfy.

    a. If we wanted to produce a product which is to hold hot dishes on a table, what is our problem?

    b. Are there other things to consider? (Note cost and aesthetic qualities.)

    c. What characteristics must our material have for this product? (Heat resistant, low heat conductivity, low cost, and pleasing to look at.)

d. List items that influence the price of material.

   1. Quantity

   2. Quality

   3. Finish

   4. Material

   5. Etc.

e. Frequently, different suppliers will have materials that fit our needs but their prices will vary. (List some prices of materials you have in the lab. Especially not the different prices for the same material.)

4. Thus, the person who purchases materials must consider whether the material satisfies a specific need and whether the price is reasonable.

5. Activity

   Selecting materials to economically satisfy product needs.

   (Assign your students on an individual or small group basis to the selection of appropriate material(s) for given products. A list of potential products is given below. Have your students define the characteristics of the materials needed for a product. Then they will use reference sources or actual experiments with materials to select the appropriate material(s) for a product. Evaluation should be based on the clarity and precision of the definition of need, and the degree to which the material(s) selected exhibit appropriate cost, mechanical, aesthetic, and other service characteristics. Possible products are: toys, tackling dummy, case for transistory radio, cone for ice cream cone, dress gloves, work gloves, baseball glove, shoes, notebook paper, ring, kitchen counter top, notebook cover, football jersey, rain coat, lubricant for bicycles, protective coating for wood, fuel for a small burner to be used in the lab, and cleaning agents.)

C. Summary

1. What is the first step in determing what material will be required for a product?

(Determine what needs the material will fulfill as a part of the product.)

2. What, then, is our next step? (Locate materials with these characteristics.)

3. Once we have located these materials, what do we do? (Select the one that fits the needs, gives the most value, and is available when needed.)

V. Evaluation

A. What materials characteristics are important for your bicycle seat?

B. What materials characteristics are important for your shirt?

C. What materials characteristics are important for the food you eat?

D. What materials characteristics are important in a basketball?

MATERIALS SELECTION - FABRICATION REQUIRED

LEVEL I - American Industry
UNIT IV - Operating an Enterprise
Lesson 11 - Materials Have to be Processed (1 period)

Stout State University
Summer, 1967

I. Objectives: At the conclusion of this lesson the student should be able to:

State that processes change materials into forms which have greater utility in satisfying needs and that the characteristics of materils influence the selection of the process.

II. Scope

Previous materials lessons have defined a number of characteristics of materials and some simple testing procedures. This lesson considers another characteristic, toolability, and provides a natural bridge to the ensuing processes lessons.

III. Resources

A. Instructional media

1. Tools and equipment: scissors, tin snips, crosscut saw, hacksaw, oven, and ladle.

2. Ditto copies of the activity sheet.

3. Materials: paper, cloth, aluminum foil, burlap, aluminum sheet, sheet metal, plastic film, ¼" plastic sheet, ½" plywood, pine board, oak board, steel rod, aluminum bar stock, steel bar stock, plastic granules, solder, ice, butter, color crayon, chocolate, and oil.

B. Literature

1. Technical books on processing.

IV. Content outline

A. Introduction

1. In the last three lessons, we have seen and tested various characteristics of materials.

2. Another characteristic of materials is their toolability--the ease or difficulty of changing the form of a material to a new, more desired form.

B. Activity and content

1. In home construction, materials such as plywood, 2 x 4's, pipe, paint, and natural gas were purchased.

   Tools and machines were used to change the form of these materials into functional parts of the house or in the case of the gas, to produce energy which was needed to produce the house.

2. Today you are going to experiment with cutting and melting various materials.

   a. Remember to use the systematic approach you learned in research as you perform the tests.

   b. Be sure to carefully record your results.

   c. Also, as you cut and melt different materials, compare what happens to each material and how the processes are alike. For example, compare the cutting process as you cut paper, plastic, and sheet metal.

3. Activity #1

   Cutting and melting materials.

   a. (Set up stations with three different sets of materials as described below. Provide enough stations so that each student can engage in the activity.)

      (1) (Scissors and tin snips, paper, cloth, aluminum foil, burlap, aluminum sheet, sheet metal, and plastic film.)

      (2) (Crosscut saw and hacksaw, ¼" plastic sheet, ½" plywood, pine board, oak board, steel rod, aluminum bar stock, and steel bar stock.)

      (3) (Oven and ladle, plastic granules, solder, ice, aluminum, steel, wood, butter, parafin (wax), chocolate, and oil.)

b. (Hand out the activity sheets.)

c. (Instruct your students on the proper use of the tools and equipment, especially the saws and oven. Also, be sure they know the proper names for the tools.)

d. (Supervise the activity.)

C. Summary

1. (Discuss the results of the activity.)

a. (Compare the similarities between processing different materials.)

b. (Discuss why different sizes of the same material require different tools. For example aluminum foil, aluminum sheet, and aluminum bar stock.

2. (Note how the amount of energy required to process different naterials varies.)

V. Evaluation

A. Place sets of materials at various stations and request your students to process them and compare the similarites between processes. For example, place samples of plywood, wood, plastic, aluminum, steel, and cement block at a station. Instruct your students on how to use each drill bit. Restrict their use of specific drill bits to certain materials--unless you have old bits you are not concerned about preserving. Ask your students to compare the drilling process between materials and to identify the reasons for the design of the specific drill bits.

Unit IV
Lesson 11
Activity #1

Name______________
Date______________

Directions: Follow the instructions given to you on this sheet and those given to you by your instructor.

I. SET I: Cut these materials as instructed and then answer the questions.

A. Cut the following materials with the scissors:

1. Paper.
2. Cloth.
3. Aluminum foil.
4. Burlap.
5. Plastic film.

B. Questions:

1. How was the cutting process similar for each material?
2. How much effort (energy) was required to cut each material?
3. Why is more effort required to cut each material?
4. Can you name any other materials that could be cut this way?

C. Cut the following materials with the tin snips:

1. Aluminum sheet.
2. Sheet metal.

D. Questions:

1. How was the cutting process similar for each material?
2. How much effort (energy) was required to cut each material?
3. Why is more effort required for some materials?
4. Can you name any other materials that could be cut this way?
5. How are the scissors and the tin snips alike?
6. How are they different?
7. Which tool allows you to apply the most force on the cutting edge? Why?

Directions: Move on to Station II.

II. SET II: Cut these materials as instructed and answer the questions

A. Cut the following materials with the crosscut saw:

1. 1/4" plastic sheet.
2. 1/2" plywood.
3. Pine board.
4. Oak board.

B. Questions:

1. How was the cutting process similar for each material?

2. Which material required the most energy to cut? Why?

3. Can you name any other materials that could be cut this way?

C. Cut the following materials with the hacksaw:

1. Steel rod.
2. Aluminum bar stock.
3. Steel bar stock.

D. Questions:

1. How was the cutting process similar for each material?

2. Which material required the most energy to cut? Why?

3. Can you name any other materials that could be cut this way?

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4. How are the two saws alike?

5. How are they different? Why?

6. Which of the saws allows you to apply the most force on the cutting edge?

7. Which saw takes the largest bite?

8. How is the cutting process with a saw different from the cutting process with a scissors or tin snips?

9. Why would you use a saw instead of a scissors?

III. SET III: Cut these materials as instructed and answer the questions.

A. Melt the following materials:

1. Plastic granules.
2. Solder.
3. Ice.
4. Aluminum.
5. Steel.
6. Wood.
7. Butter.
8. Color crayon.
9. Chocolate (no testing allowed).
10. Oil.

B. Questions:

1. Which materials were easiest to melt?

2. Were you able to melt all of the materials? List the ones you were not able to melt.

3. What happened to the oil when you heated it?

4. What materials could be melted without the oven?

5. Which materials require the most energy to melt?

6. How is the melting process different from the cutting process?

7. When would you melt materials rather than cut them?

ACTIVITY No. ________________

TASK ANALYSIS

The following activity is intended to be used after the lessons on materials and processes have been completed. It may be used as a culminating activity involving small groups or individual student participation.

Unit IV
Lesson 16
Activity #1

Name________________________
Date________________________

Directions: Complete the tasks described below and answer the questions. You will find your tools and materials at the station with the same number or the process number given below. Work safely!

Process #1: Planing

1. Set the plane to take a shallow cut. Plane an edge of the pine board and then plane an edge of the oak board.

   A. Which wood took the most energy to plane?____________________

   B. On which board did you get the smoothest edge?____________________

   C. Were you more skilled when you planed the second material?__________

   D. How did the differences in materials influence the process?__________

   ____

2. Using the shallow setting, plane an edge of the pine board. Now, set the plane to take a very deep cut. Plane the other edge of the pine board.

   A. Which setting required the most energy?____________________

   B. Which setting gave the smoothest cut?____________________

   C. Did your level of skill change between the time you made the cuts with the two different settings?____________________

   D. What caused the difference in the quality of the cuts?__________

   ____

Process #2: Drilling

1. Use the hand drill to drill a one-quarter inch hole straight through the piece of wood and the piece of steel. Drill each piece separately.

   A. Which material required the most energy for completing this process?

   ____

B. In which material did you make the most accurate hole? Why?

____

C. What problems did you have in drilling straight through each material?

____

2. Use the drill press to drill a one-quarter inch hole straight through the same materials. Caution: Wear safety glasses, hold the piece of steel with a clamp or a pliers, and follow the safety rules given by your instructor.

A. Which material required the most energy to drill?______________

B. Did you have to use more energy to drill one piece than the other?

____

C. Where did the extra energy come from?__________________

D. Were the holes straight? Why?______________________

____

E. What did you have to do to drill the holes with the drill press?_______

____

F. How was this different from drilling the holes by hand?____________

____

____

G. Are different skills involved in doing the same process when different tools are used in doing it?_______________________

Process #3: Painting

1. Dip the paint brush one-third of the length of the bristles into the paint. Brush the paint onto the panel.

2. Roll the paint roller into the paint in the tray. Roll out the excess paint. Then, roll the paint on the panel just below or above where you brushed on the paint.

A. Which tool gave the best application?____________________

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B. Which is faster?____

C. Which tool requires the most skill to do a good job?_______________

4. Take a paper cup of paint and mix it with two cups of water. Next, apply this new material with the brush and the roller.

A. What problems did you have applying this paint?__________________

____

B. Did you get as good an application with either of these tools as you did with the original paint?_______________________________________

____

C. What influence do the tools and the consistency of the paint have on this process?____

____

____

5. Before you leave this station wipe the brush and the roller to remove the excess paint. Place the thin paint in the can marked "waste paint."

Process #4:____________________

1. Method A:\____

A. Tools:____

B. Skills:____

C. Procedure:____

D. Material(s):____

E. How do these affect each other?_____________________________

____

____

2. Method B: ____________________

   A. Tools: ____________________

   B. Skills: ____________________

   C. Procedure: ____________________

   D. Material(s): ____________________

   E. How do these affect each other? ____________________

3. Comparison of the two methods, A and B.

   A. Which method requires the most energy? ____________________

   B. Which method requires the most manipulative skill? Why? ____________________

   C. What manipulative skills do the tools used in Method B replace? ____________________

   D. How do the characteristics of the material influence the selection of tools and the skills required? ____________________

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STUDENT PLAN SHEET
Processes - Refining

ACTIVITY TITLE Refining Cotton

NAME ____________

TOTAL COST ____________

PERIOD ____________

CONTENT AREA - RAW MATERIALS

PROCESSES

FORMING ✓

SEPARATING ✓

COMBINING ✓

CONDITIONING ____________

FINISHING ____________

MATERIALS

METALLIC ____________

CERAMICS ____________

POLYMERS ____________

FIBEROUS ____________

COMPOSITES ____________

DRAWING

Safety

1. Do not place hands near face when using cleaning solution.
2. Wash hands after using cleaning solution.
3. Avoid prolonged breathing of cleaning solution fumes.

TOOLS AND EQUIPMENT

Equipment (Group of 5)

1	metal-bristled brush (A dog brush is suitable.)
4	pocket combs
10	¾" x 2" x 2" blocks of wood covered with 3/0 abrasive paper (Cut blocks from scrap and cement or glue paper to surface.)
1	shallow container (A metal baking pan, 1½" x 10" x 10", will serve.)
1	3" dia. funnel

Supplies (Group of 5)

5	5" cardboard mailing tubes *or*
5 pcs.	¾" dowel, 5" long
5	cotton bolls
1 pt.	cleaning solution (mineral spirits paint thinner), in stoppered, labeled container
1 pkg.	paper towels

PROCEDURES

1. Assemble with your group at your work station and obtain the equipment and supplies.
2. Review safety precautions with your instructor.

Refining

3. Pick all seed and chaff material from the bolls.
4. Wash the lint (the cotton fiber) which remains. Fill the shallow pan with about one pint of cleaning solution. Dip the cotton fiber into the fluid and agitate it gently.
5. Remove the fibers and place them on paper towels to dry.
6. While the fiber is drying, pour the cleaning solution back into its container, put on the stopper, and store it in a fireproof location.

Combing

7. After the fiber is dry, use the comb or brush to comb out the refined cotton into long, parallel strands. Short combing strokes should be used at first. As the cotton fibers become separated, longer strokes should be used. Try to make the fibers parallel.

Twisting

8. Twist the short strands into one long, continuous strand. Place the combed strands of cotton between the two abrasive blocks. As you shuffle the blocks gently together in one direction, the combed fibers are formed into a continuous strand of yarn. . In producing the yarn, care must be taken to assure a uniform thickness. If during the twisting process the yarn becomes irregular in diameter, comb it back into strands of fiber and repeat the process.

Collecting Standard Stock

9. As the continuous strand is produced, it must be collected on a spool. The cardboard mailing tube or dowel rod will serve as a spool. Coil the twisted yarn onto the spool.
10. Return all equipment and supplies to their proper location in the room. Dispose of chaff and waste paper.

STUDENT PLAN SHEET
PROCESSES - EXTRACTION

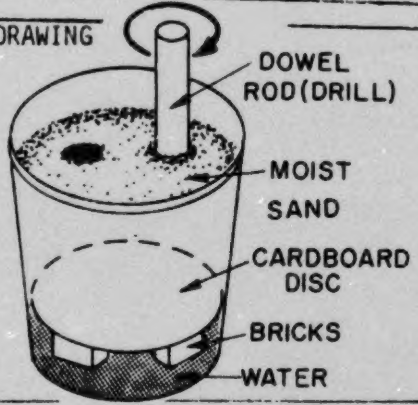
ACTIVITY TITLE Extracting Raw Materials NAME ____________

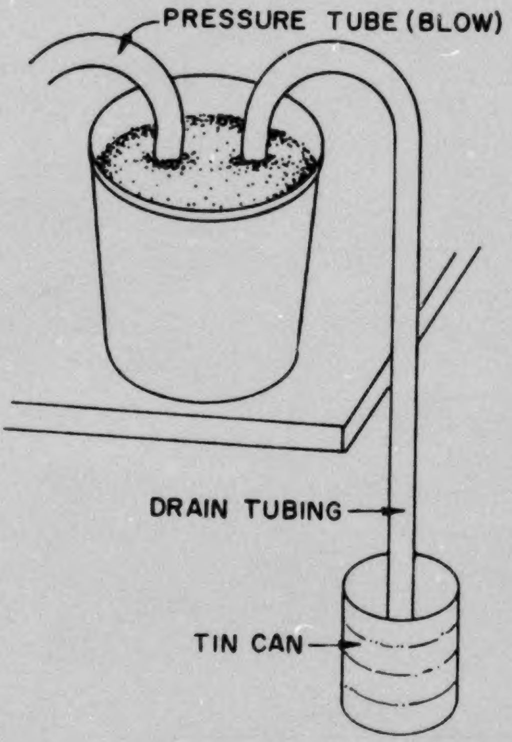
TOTAL COST ____________ PERIOD ____________

CONTENT AREA - Materials - Natural - Liquid

PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING		COMPOSITES	

DRAWING


DOWEL
ROD(DRILL)
MOIST
SAND
CARDBOARD
DISC
BRICKS
WATER


PRESSURE TUBE (BLOW)
DRAIN TUBING
TIN CAN

TOOLS AND EQUIPMENT

Equipment

1	5 qt. plastic bucket
1 pc.	3/8″ dia., 24″ length, polyethylene tubing
1 pc.	3/8″ dia., 18″ length, dowel rod (sharpened)
1	large tin can (32 oz. or more)
1 pc.	3/8″ dia., 36″ length, polyethylene tubing

Supplies

1	corrugated cardboard disc
1	#10 tin can *or* bucket
1 bucket	moist sand
3 pcs.	common brick

Presentation - Demonstration

Today's lesson concerns extracting raw materials from nature.

1. All materials that are extracted are of the nonreproducible type. For example, a coal mine will not grow or produce new coal. Coal may be taken from a mine, but the coal mine will never replenish itself.
2. We extract from the surface of the earth, within the earth, above the earth (in the atmosphere), and from the earth's waters. The following demonstration will show you how raw materials in a liquid or gas form are extracted. Gas, oil, and water are extracted by drilling and pumping.
3. Set up the materials as shown in Fig. 84-1. Do not insert drill yet.
4. Using the sharpened dowel as a drill, rotate it between your hands to sink two shafts down through the sand and cardboard into the underground deposit. Wiggle your drill around to make sure the shaft hole is big enough. See Fig. 84-1.
5. Remove the drill. Insert polyethylene tubing as a casing into both shafts, down to the deposit.
6. Place the bucket near the edge of the table so that the end of the longer piece of tubing will be below the bottom of the bucket. Place the tin can under the end of the tubing. See Fig. 84-2.
7. Imitate the pressure naturally found in an oil deposit by blowing into the short tube until water flows out of the long one.

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STUDENT PLAN SHEET
PROCESSES - REFINING RAW MATERIALS

ACTIVITY TITLE REFINING OIL

NAME ______

TOTAL COST ______

PERIOD ______

CONTENT AREA

PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING		COMPOSITES	

DRAWING

TOOLS AND EQUIPMENT

Equipment (Group of 5)

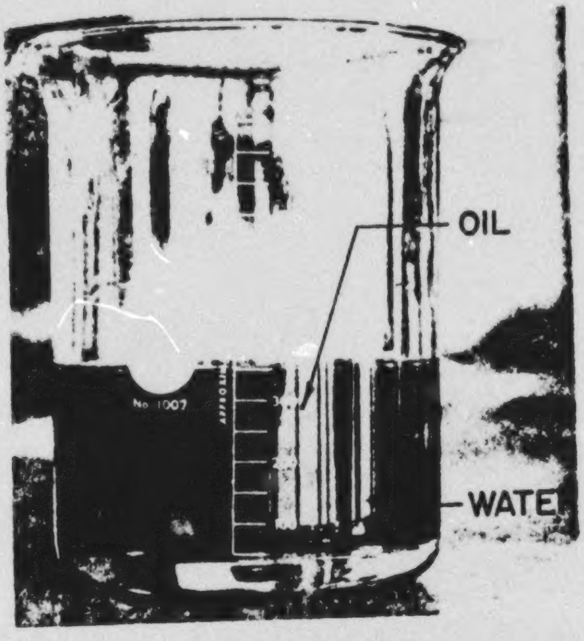
1	3" dia. funnel
2	1000 ml. glass beaker
1	6" bar magnet
1 pc.	flexible tubing for siphon
1 pr.	long-nosed pliers

Supplies (Group of 5)

1 pc.	4" x 4" cardboard
1 qt.	contaminated oil in quart jar (10W oil)
1 pc.	5" x 5" cloth
½ lb.	sand and gravel mixture
1 pkg.	paper towels
1	12" length of string
1	plastic sheet

PROCEDURES

Move the Magnet through the Oil



Oil Floating on Top of the Water

Demonstration

Oil never wears out, but it becomes contaminated with use. Therefore, it must be refined if it is to be used again. Today I will demonstrate how to refine contaminated oil. (Explain each step as you demonstrate.)

1. Spread a plastic sheet over the bench top.
2. Obtain a quart of contaminated motor oil. (See Laboratory Activity section.) Shake it well to suspend all of the impurities in the oil.
3. Place the piece of cloth into the funnel and add the sand and gravel mixture to the funnel. This will serve as a filter.
4. Place the funnel over the glass beaker. Punch a hole in the 4″ x 4″ piece of cardboard to support the funnel over the beaker.
5. Pour oil into the funnel, a little at a time, until about one half of the quart has been filtered.
6. Obtain a 6″ bar magnet. Move the magnet through the filtered oil. Any steel particle in the oil should be attracted to the magnet.
7. Wipe the metal particles off the magnet with *paper towels;* do not use anything else.
8. Allow the filtered oil to stand in the glass beaker for about 5 minutes. While it is standing, discard the filtering mixture and clean the magnet and funnel.
9. In about 5 minutes the oil will have risen above the water. The next step is to remove the water which has settled below the oil. Siphon out the water using a piece of flexible tubing, as follows: Fill the tubing with water. Hold one end closed with the pliers. Be careful not to allow air to enter the tubing. Insert the pliers and tube end into the beaker until it reaches the water at the bottom of the beaker. The other end of the tubing should be placed into an empty beaker.
10. In the petroleum industry after the physical impurities have been removed, the next step in reprocessing contaminated oil is to remove the chemical impurities. Due to the dangers involved, we will not perform this step.
11. The refining operations are now complete. Compare the refined oil with the remaining contaminated oil in the original container. They will be different to sight, smell, and touch.

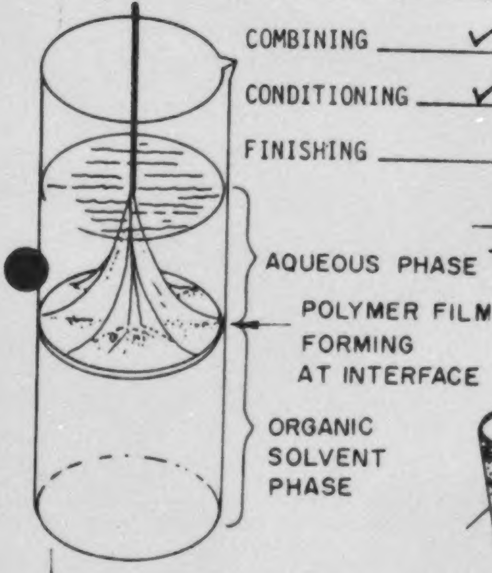
STUDENT PLAN SHEET
PROCESSES - REFINING SYNTHETIC MATERIALS

ACTIVITY TITLE MAKING NYLON NAME ____________

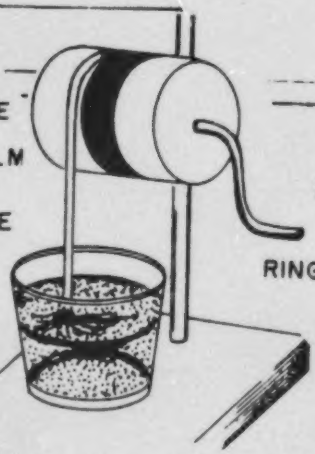
TOTAL COST ____________ PERIOD ____________

CONTENT AREA Materials - Synthetic

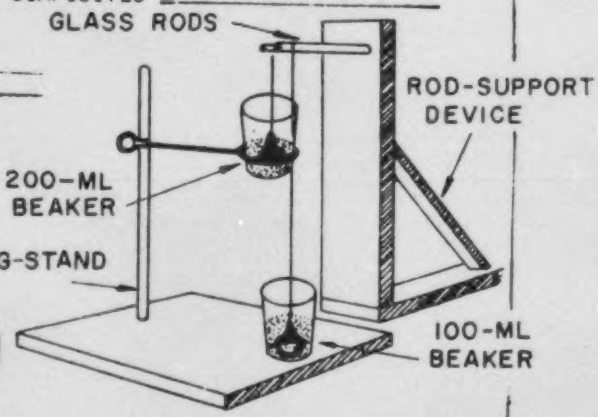
PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING		CERAMICS	
COMBINING	✓	POLYMERS	✓
CONDITIONING	✓	FIBEROUS	
FINISHING		COMPOSITES	


AQUEOUS PHASE
POLYMER FILM FORMING AT INTERFACE
ORGANIC SOLVENT PHASE

Pulling Polymer Film



Manual Winding Device for Continuously Removing Polyamide Film from an Interface


GLASS RODS
ROD-SUPPORT DEVICE
200-ML BEAKER
RING-STAND
100-ML BEAKER

Continuous Flow of Nylon Fiber

TOOLS AND EQUIP

Equipment

1 pr.	tweezers
5 pr.	rubber gloves
1	200 ml., tall-form beaker (2¼" inner diameter)
1	100 ml. volumetric pipet, w/rubber bulb
2	100 ml. beakers
1	covered metal waste can, for disposal of materials

Supplies

2 ml.	sebacoyl chloride (Eastman Kodak #6236)
100 ml.	carbon tetrachloride azobenzene (a few drops for color)
4.4 gm.	hexamethylene diamine (Eastman Kodak #P5932)
1 pt.	50% aqueous alcohol *or* acetone
50 ml.	water
1 pkg.	paper towels
1 bundle	newspapers

PROCEDURES

Introduction

1. In your reading you learned about several kinds of processes that transform or change one chemical into another. Today I will demonstrate one of these processes: it is called *polymerizing* or making a *polymer*.

Safety Precautions

1. Wear rubber gloves.
2. Perform demonstrations on a stone or other acid-resistant bench top, a glass plate, or a thick pad of newspapers.
3. When chemicals are measured with the pipet, use rubber bulbs. Never use your mouth to draw up the fluid.
4. The demonstration should be performed under a hood or in a large, well-ventilated room.
5. The chemical residues should be disposed of after the demonstration or placed in a closed container.
6. Avoid breathing vapors of carbon tetrachloride, as well as having skin contact with this solvent.
7. *Do not* use any heat of any type for this demonstration.
8. The rope of polymer film should be handled only with rubber gloves, tongs, and forceps until it has been washed free of solvent and reactants.

Demonstration 1

Perform the demonstration as outlined here. Work on an acid-resistant surface. It is recommended that you perform the whole procedure prior to the day it is to be demonstrated. See Safety Precautions.

1. Preparing Solutions
   a. Prepare the organic solvent. Mix 2 ml. sebacoyl chloride in 100 ml. carbon tetrachloride. (See Safety Precautions.)
   b. Prepare the aqueous solution. Mix 4.4 grams hexamethylene diamine in 50 ml. water.
   c. Add azobenzene to the organic solvent. This will give color to the solution and enhance the visibility of the liquid interface.
2. Mixing Phases (Solutions)
   a. Place the organic solvent phase in a 200 ml. tall-form beaker.
   b. Carefully pour the aqueous phase over the organic solvent phase. This aqueous phase, being lighter than the organic solvent phase, will float on top.
3. Obtaining Polymer
   a. A *polymeric* film will form at once at the interface. This film usually is irregular and contains air sacs and bubbles. Be sure that all your students are grouped so they can watch it form.
   b. Remove this irregular film.
4. Forming Nylon Fiber
   a. Using a pair of tweezers, grasp the chemical mass at the center and pull upward.
   b. The film will always form a tent with draping and shifting folds. The apex will be at the air-liquid interface.

Note

At this point you may wish to have several students pull out the nylon, rope-like film. See Fig. 92B-2 for optional method.

5. Cleaning and Drying
   a. Wash the fiber thoroughly with a 50% aqueous alcohol or acetone solution.
   b. Allow the fiber to dry in the air.

STUDENT PLAN SHEET
FORMING - 05

ACTIVITY TITLE HOT & COLD FORGING

NAME ____________________

TOTAL COST ____________________

PERIOD ____________________

CONTENT AREA

PROCESSES

FORMING ✓

SEPARATING ____________________

COMBINING ____________________

CONDITIONING ____________________

FINISHING ____________________

MATERIALS

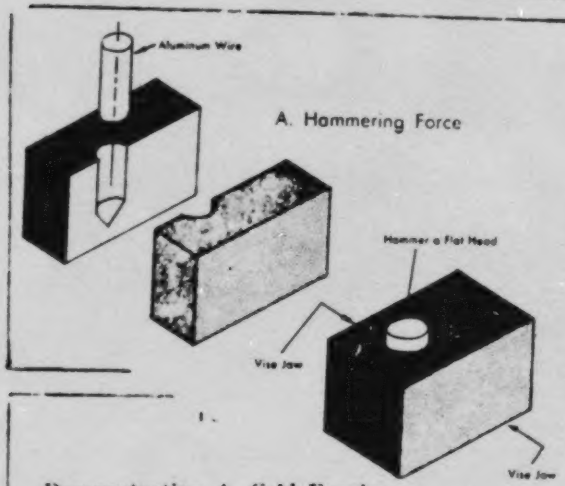
METALLIC ✓

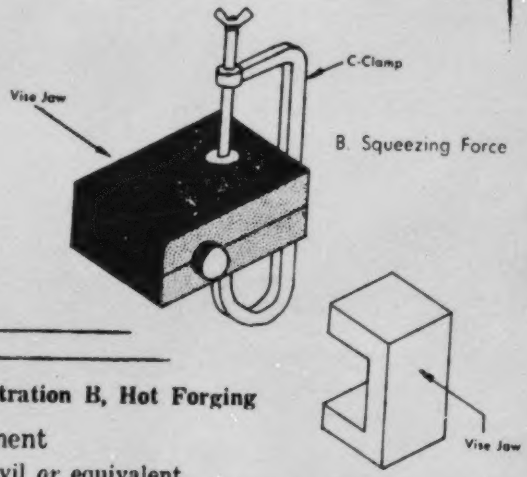
CERAMICS ____________________

POLYMERS ____________________

FIBEROUS ____________________

COMPOSITES ____________________


Aluminum Wire
A. Hammering Force
Hammer a Flat Head
Vise Jaw
Vise Jaw


C-Clamp
Vise Jaw
B. Squeezing Force
Vise Jaw

Demonstration A, Cold Forging

Equipment

1 overhead projector w/screen
1 13 oz. ball peen hammer
1 vise
1 rivet jig No. 101
1 C-clamp

Supplies

1 Transparency 101, *Changing the Shape of Solid Materials*
2 pcs. 1/8" dia. x 3/8" soft aluminum wire

Demonstration B, Hot Forging

Equipment

1 anvil *or* equivalent
1 propane torch w/blowtorch head
1 spark lighter
1 13 oz. ball peen hammer
1 pr. vise grips, wrench, *or* multigroove pliers
1 10" smooth mill file
1 pr. asbestos *or* welding gloves
1 pr. safety glasses
1 set vise jaw covers

Supplies

1 pc. 3/16" dia. x 6" drill rod

PROCEDURES

Presentation -

In compressing or stretching processes, solid material usually is given a desired shape without melting it. The material must have a special property or characteristic to make it suitable for one of these processes.

1. Show Transparency 101, *Changing the Shape of Solid Material.* If a solid material is to be forced into a different shape, it must not be brittle. If it is hard and brittle, it will fracture or break rather than change its shape.
2. For compressing or stretching processes, the material must yield or "give" without breaking.
3. If the shape of a solid material can be changed by hammering or rolling, the material is *malleable.* A *mallet* is a hammer, and *malleable* means "hammerable." Gold, lead, and copper, for example, are malleable materials.
4. *Forging* means using pressure to give material a desired shape. Forging processes are done either with a repeated *hammering* force or with a continuous *squeezing* force.
5. If the shape of a solid material can be changed by stretching or pulling, the material is *ductile.* Copper drawn into wire is an example of a ductile material. Some materials are both malleable and ductile.
6. Materials that can be squeezed into a new shape are *plastic.* Examples are clay and toothpaste.
7. Many materials become more malleable, or ductile, or plastic, as they are heated.
8. Some metals can be forged at room temperature; others are heated before-hand. Today I will demonstrate both cold forging and hot forging.

Demonstration A, Cold Forging

1. Demonstrate how an aluminum rivet head can be formed by a hammering force. See Fig. 101A.
2. Demonstrate how an aluminum rivet head can be formed by a squeezing force. See Fig. 101B.
3. The heads on nails and similar fasteners are made by a process called *cold heading,* which is very similar to these examples.

Demonstration B, Hot Forging

1. In the laboratory today, students will forge a blade for a screwdriver.
2. Demonstrate the forging technique used to produce a screwdriver blade.

STUDENT PLAN SHEET
PROCESSES - REFINING

ACTIVITY TITLE Story of Primary Metals

NAME

TOTAL COST

PERIOD

CONTENT AREA Refining Natural Resources

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING		COMPOSITES	

DRAWING

TOOLS AND EQUIPMENT

Supplies (Group of 5)

5 lb.	pig lead
25 lb.	molding sand
1 lb.	nonsilica parting compound *or* talcum
5	mold patterns (24-pica slugs)
10 pcs.	½" x 2" x 6" common lumber
10 pcs.	½" x 2" x 5" common lumber
40	6d common nails
10	8" x 8" molding boards (½" plywood)

PROCEDURES

Demonstration (15)

Today the teacher will demonstrate heating a primary metal (lead) into a molten state, refining it by removing the impurities (slag), casting it into a slab, and rolling it into sheet stock.

1. Explain how to melt metal. Have the equipment for melting metal set up before class and the metal already heating.
2. While the metal is melting, explain how to ram a one-piece mold. Use the following steps as a guide.
   a. Set flask on bottom molding board.
   b. Place mold pattern inside flask.
   c. Sprinkle on parting compound (or talcum) to cover mold pattern.
   d. Screen sand until mold pattern is covered.
   e. Put in remaining sand and ram mold.
   f. Strike off excess sand.
   g. Place other molding board on flask. Holding flask and molding boards very tightly, turn over flask.
   h. Remove bottom molding board, then mold pattern.
3. When the lead is melted, demonstrate the procedure of refining the metal by skimming off the slag (impurities). Heat the skimmer to prevent it from spattering the metal.
4. Demonstrate how to pour the lead into the sand mold. Emphasize the use of the asbestos gloves. Care should be exercised not to pour too much metal into the mold.
5. Using a slab of lead cast previously, demonstrate how to adjust and use the slip roll to reduce the cast lead slab into sheet stock.

Discussion (5)

The students are about to duplicate what you have showed them in their laboratory activity. This discussion will reinforce points from the demonstration.

1. How are impurities removed from lead? (The lead is heated to its melting point. Then the impurities in the lead, being lighter than the metal, float to the surface of the metal. These impurities are then skimmed off mechanically.)
2. Why is a sand mold used for casting objects from molten metal? (It will conform to the shape of any desired die; it will hold the shape of the desired casting; and it will not melt or ignite when molten metal is poured into it.)
3. How are metal slabs formed into sheet stock? (The slab is rolled between two rollers. The distance between the rollers is reduced gradually so that the metal slab keeps getting thinner. Finally, it is flattened to a sheet of the desired thickness.)

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PRODUCT IDEAS

The following group of product ideas can be used by the instructor as hands on activities to reinforce different material and processes areas. These activities are intended to get the student, individually or in production groups, involved with materials of industry and processes use to transform these materials. The activity should provide the student with the opportunity to select proper tools, equipment, and supplies as dictated by the different properties and characteristics of materials.

It is also intended that the enclosed ideas be used as examples and lead to the development of new and different activities utilizing all of the material areas and incorporating all of the process areas.

STUDENT PLAN SHEET

ACTIVITY TITLE Material Development

NAME ______

TOTAL COST ______

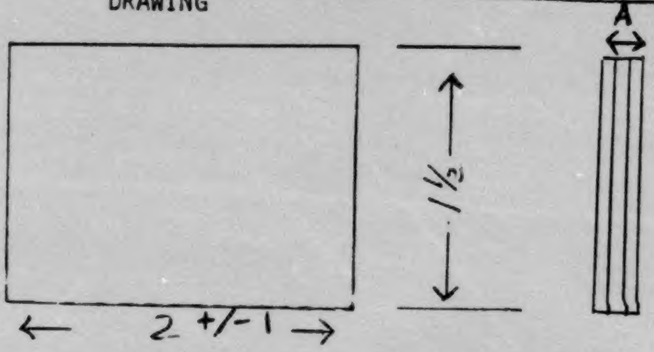
PERIOD ______

CONTENT AREA

Industrial Materials

PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING	✓	POLYMERS	
CONDITIONING		FIBEROUS	✓
FINISHING	✓	COMPOSITES	✓

DRAWING



Dim. "A" equal to the thickness of 3-5 or 7 pieces of veneer glued face to face at right angles to each other

TOOLS AND EQUIRMENT

- Veneer Stock
- Glue
- Clamps or Press
- Pencil - Paper
- Scroll Saw
- Wood Rasp
- Sur-Form File
- Abrasive Paper
- Drill - Hand - Press
- Leather Lace or Neck or Wrist Chain

PROCEDURES

1. Blank out 3-5-7 pc. of veneer stock. Dimensions are flexible. Veneer stock should be of different wood species.
2. Glue and clamp veneer pc. together at right angles to each other to form a piece of plywood.
3. Develop freeform shape. Do this by scribbling on a piece of paper. Select shape pleasing to the eye and of a size that can be used for neck or wrist pendant.
4. Cut design out and paste or tape to developed ind. material.
5. Cut shape using hand or power tool.
6. Sculpture shape using drum sander, wood files, abrasive paper to decided contour.
7. Locate string or chain hole and drill to desired size.
8. Apply finish to enhance the wood structure.
9. Assemble chain or other material used with pendants.

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STUDENT PLAN SHEET

ACTIVITY TITLE Decorated Scoop or Lantern NAME ____________

TOTAL COST ____________ PERIOD ____________

CONTENT AREA

Introduce Student to a varity of materials, process methods, tool application.

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING

SEE ATTACHED PRINT

TOOLS AND EQUIPMENT

Lacquer thinner
Metal Primer
Spray paint - wrought iron black or flat
Florist Styrofoam
Synthetic Christmas Brush
Ribbon
Spray Snow, etc.

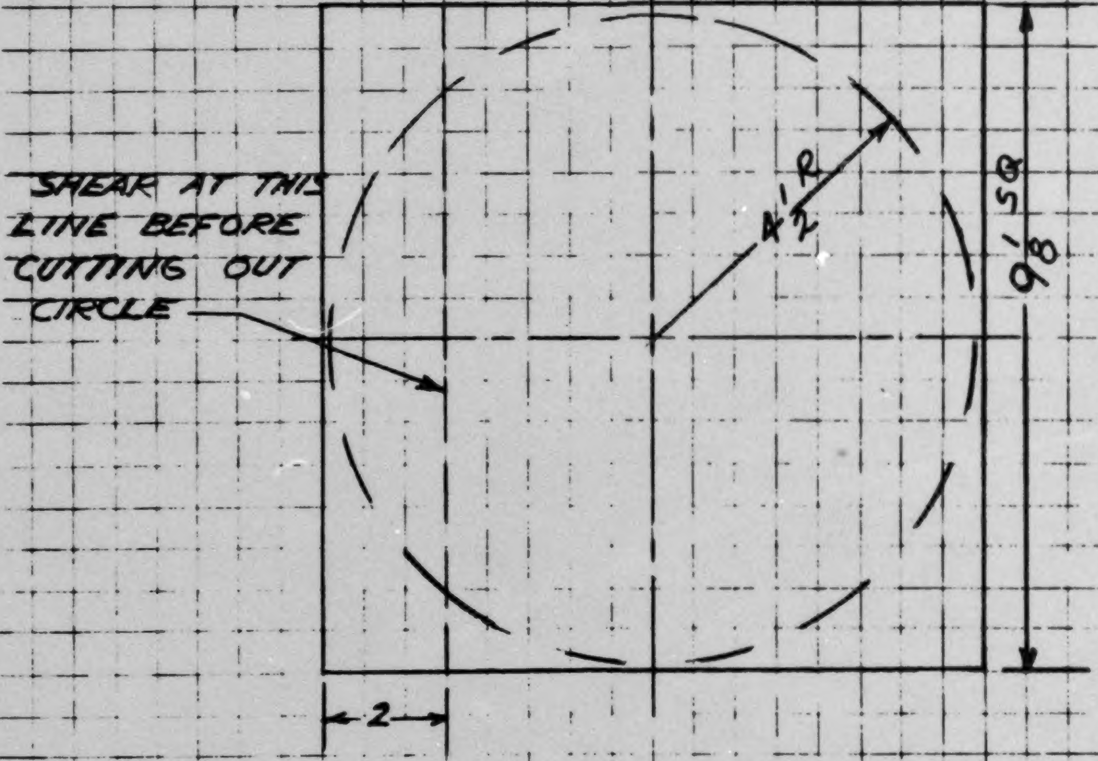
PROCEDURE

Using the developed drawings and specifications, fabricate the scoop per plans. When completed:

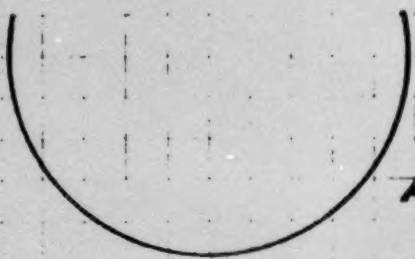
A. Clean with lacquer thinner
B. Prime with metal primer
C. Spray paint flat or wrought iron black
* D. Using florist styrofoam, synthetic Christmas brush, ribbon, spray snow, etc. complete a center piece that can be given as a Christmas present.
E. Complete the product analysis handout.

* This process can be done as a group with an outside person helping to direct the decoration of the centerpiece.

Form FX-01


SHEAR AT THIS LINE BEFORE CUTTING OUT CIRCLE
4 1/2 R
9 1/8 SQ
2

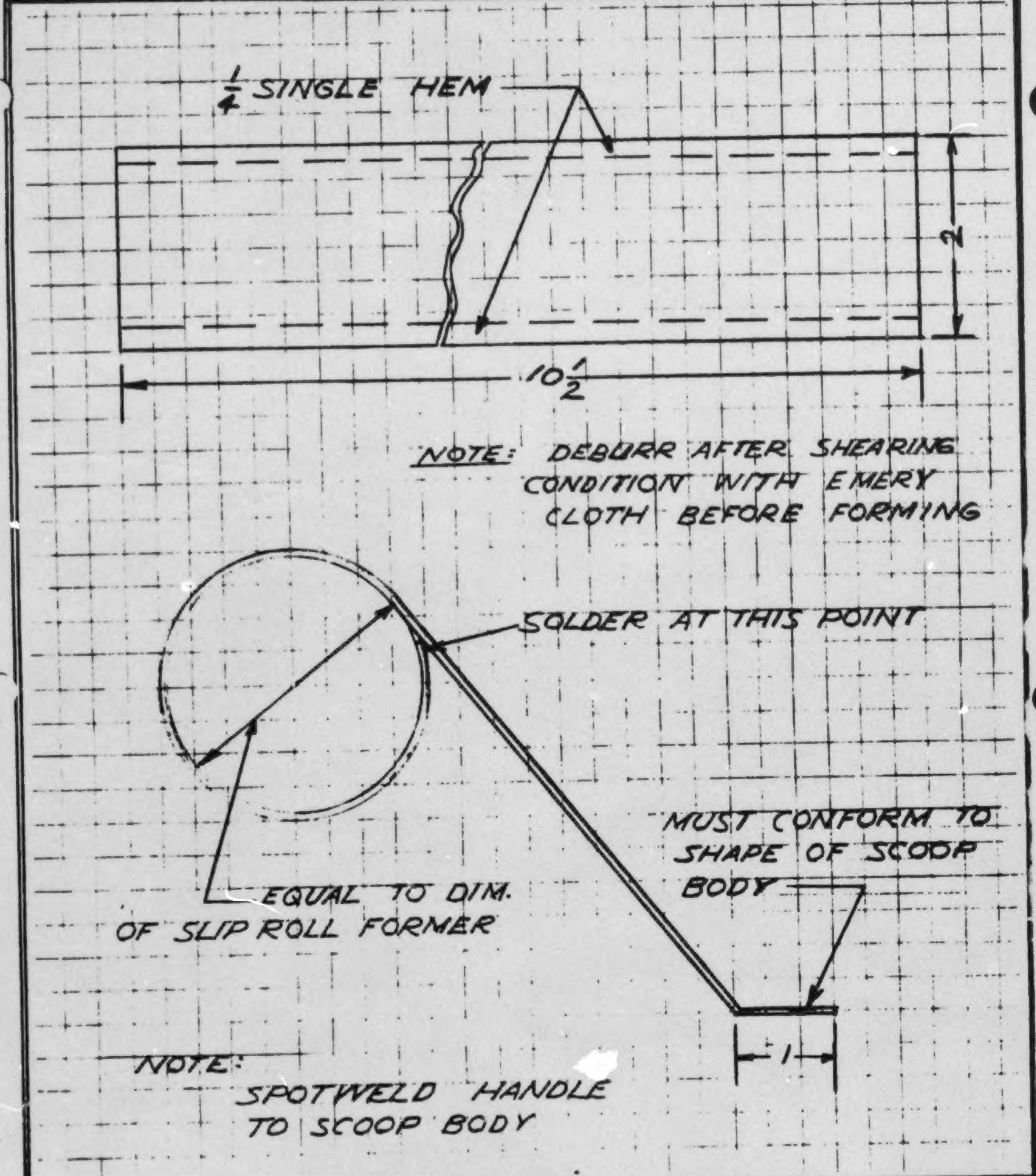
NOTE: DEBURR AFTER SHEARING.
CONDITION WITH EMERY CLOTH BEFORE FORMING.



FORMED VIEW

TERM		YEAR		COMPANY NAME		DRAWING or CHART DESCRIPTION
DEPT				[illegible]		SCOOP BODY 28 GA. TIN PLATE
DIV.						
DWN BY				DATE		
CKD BY				DATE		SCALE Eng._____ Met._____ NO.___of___

Form FX-01

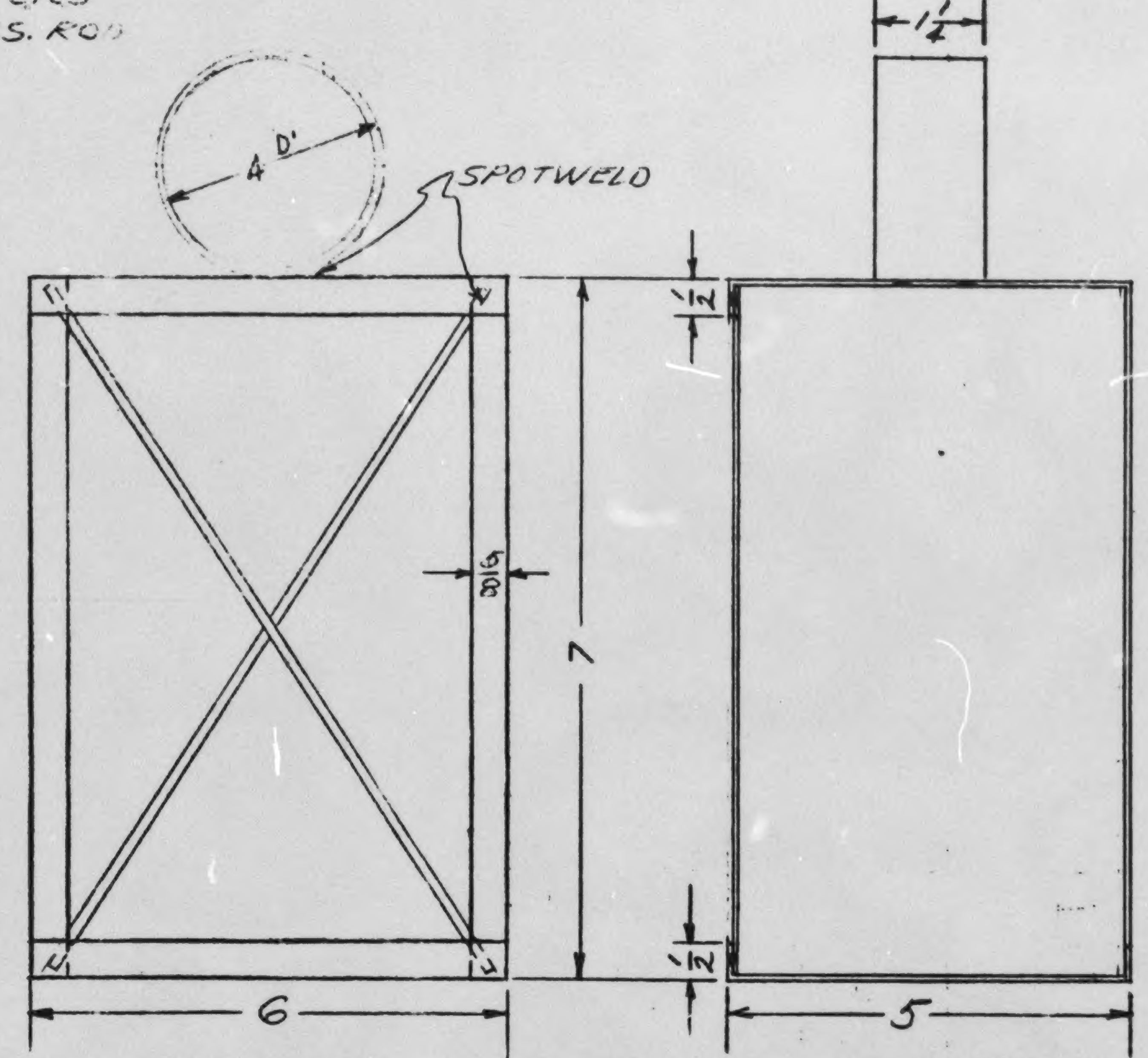


1/4 SINGLE HEM
2
10 1/2
NOTE: DEBURR AFTER SHEARING
CONDITION WITH EMERY
CLOTH BEFORE FORMING
SOLDER AT THIS POINT
MUST CONFORM TO
SHAPE OF SCOOP
BODY
EQUAL TO DIM.
OF SLIP ROLL FORMER
1
NOTE:
SPOTWELD HANDLE
TO SCOOP BODY

TERM	YEAR	COMPANY NAME		DRAWING or CHART DESCRIPTION
DEPT		R B IMHOFF MANITOWOC, WIS.		SCOOP HANDLE 28 GA TINPLATE
DIV.				
DWN BY		DATE		
CKD BY		DATE	SCALE Eng._____ Met._____	NO.___of___

POST LANTERN

22 GA. CRS
$\frac{1}{8}$ DIA. M.S. ROD


4 D'
SPOTWELD
1 1/4
1/2
5/16
7
1/2
6
5

R.B. IMHOFF

PRODUCTION METHODS STUDY

CLASS AND PERIOD

PRODUCT NAME

TYPE OF PROCESS STUDIED ☐ Part Manufactured: Lantern Parts (part name)

☐ Sub-Assembly ______ ☐ Inspection

RESPONSIBILITY FOR PREPARATION

Production Department X

Engineering Department ______

Quality Control X

Term ______

Year ______

Date ______

PREPARED BY

DATE ______

TASK #	BREAKDOWN OF PROCESS TO BE PERFORMED	MACHINE AND/OR TOOL REQUIRED	JIG, FIXTURE, PATTERN, OR GAGE REQUIRED	SPECIAL NOTES
1	Shear Body 6 X 18	Squaring Shears		Use Stop Gauge
2	Deburr all Edges	Emery Cloth		Don't Cut Yourself
3	Layout all Bend Lines	Marking Gage, Rule, Scratch Awl, Square		Be Accurate
4.	Bend ½ inch flange	Bar Folder		Check Set up
5.	Bend Body to Shape	Box Pan Brake		Use Helper
6.	Shear Corner Strips 5/8 X 7	Shears		Make sure ends are sq.
7.	Deburr all Edges	Emery Cloth		
8.	Spot Weld Corners to body	Spotwelder		Be accurate
9.	Cut 8 3/4 Lg Cross Bars	Hacksaw Ruler		Dress Ends
10.	Spotweld Crossbars	Spotwelder		Be Accurate
11.	Shear Handle 1¼ X 12 5/8	Shears		
12.	Deburr All Edges	Emery Cloth		

TASK #	BREAKDOWN OF PROCESS TO BE PERFORMED	MACHINE AND/OR TOOL REQUIRED	JIG, FIXTURE PATTERN, OR GAGE REQUIRED	SPECIAL NOTES
13.	Form Ring	Sliproll Former		Don't Over Form
14.	Layout Center of Body Top	Ruler, Awl, Square		
15.	Spotweld Ring to Body	Spotwelder		
16.	Remove Oil	Thinner-Rag		
17.	Prime Lantern			Must dry for 2 hours
18.	Final Finish			

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PRODUCT AND TASK ANALYSIS

ACTIVITY No. ________________ NAME ____________________________

PERIOD ____________________________

Direction: Answer all questions in reference to the product completed by you.

1. List All materials used in the completion of the product.

2. How many of the materials can be classified as a natural material? As synthetic materials?

3. Did you have to form any of the materials before they could be used?

   List the forming processes you used. (check your notes or ask your instructor if you don't know)

   What tools or machines did you use for these forming processes?

4. What material properties or characteristics were necessary to accomodate the forming processes?

5. The following combining processes were used with your product. You are to identify the method used with each process.

   - Cohesion
   - Bonding
   - Mechanical Linkage

   List the machines or tools used to perform the above combining processes.

6. Products are finished for two reasons: to protect and to decorate.

   What finishing process did you use that was protective?

   What finishing process did you use that was decorative?

7. Adding all of the decorative materials to the product enhances the ________ properties of the product.

8. Cost is an important property when dealing with materials and products. What did the product cost you?

   Fabricated Body ______________
   Decorations ______________
   Total Cost ______________

   Could you but this product cheaper in a florist shop? Why?

The following activities are taken from:

Project Occupational Versatility

"The Role of the Student in the Industrial Arts Environment"

Project Occupational Versatility
Greater Albany Public School Dist. 8J
2310 South Elm
Albany, Oregon 97321

The following activities are from:

CBIE Project
A Cooperative Curriculum Effort
in the Area of
Materials & Processes

See Resource Section for Particulars

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CLASSIFICATION OF MATERIALS

PAPER

DESCRIPTION OF LESSON

The definition of paper, types of paper, and manufacturing of paper are topics for this lesson.

OUTLINE OF CONTENT

I. Definition of paper - all kinds of matted or felted sheets of fiber formed on a wire or screen from water suspension

II. Types of paper classification

   A. Paper versus paperboard

   B. Fine paper versus industrial papers

III. Fine paper - paper that is made primarily for communication purposes

IV. How paper is made

   A. Materials used
      1. Water - one ton of water used to make one pound of paper
      2. Wood pulp - Kraft, sulfite, or groundwood
      3. Waste paper
      4. Rags
      5. Pigments

   B. Processes of making paper
      1. Fourdrinier
      2. Cylinder machine

V. Conservation of paper

   A. No paper inventory - there is no surplus, it is being used as fast as it is produced

   B. Paper mills are huge investments - new ones under construction are already sold out of their future products

   C. Ecology laws have closed down mills

VI. Explain how students are to make paper by hand

BEHAVIORAL OBJECTIVES

1. From a list of descriptive phrases, the student will select an appropriate description of paper.
2. The student will describe the Fourdrinier process of making paper.
3. The student will discuss why conservation of paper is necessary.
4. Given the necessary supplies, the student will manufacture a 6" x 8" piece of writing paper.

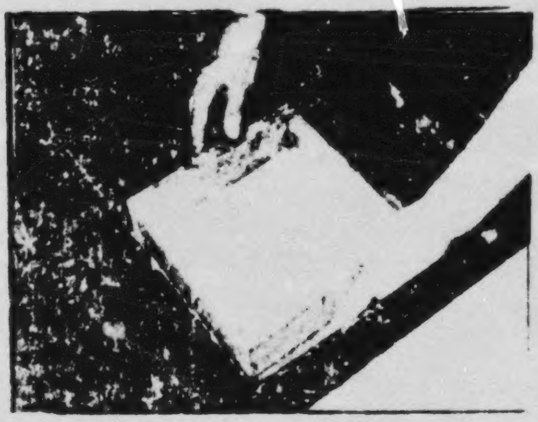
DESCRIPTION OF STUDENT ACTIVITY

The student will make a piece of fine paper by hand.

REQUIRED READINGS, SUPPLIES, AND EQUIPMENT

Readings: "Instructions for Making Paper"
See appendix A, Lesson 22 for source of second reading

Supplies: Pulp
Water
Starch
"Wire"
Egg beater
Water tub
Rolling pin
Paper blotters
Electric iron

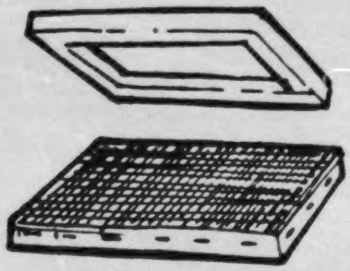


WET PULP ON "WIRE"

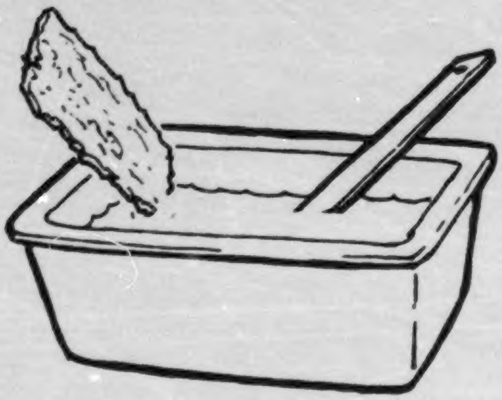
HANDMADE PAPER

MAKING FINE PAPER

A piece of hand-crafted paper, approximately 6" x 8", is to be made by the procedure shown below.

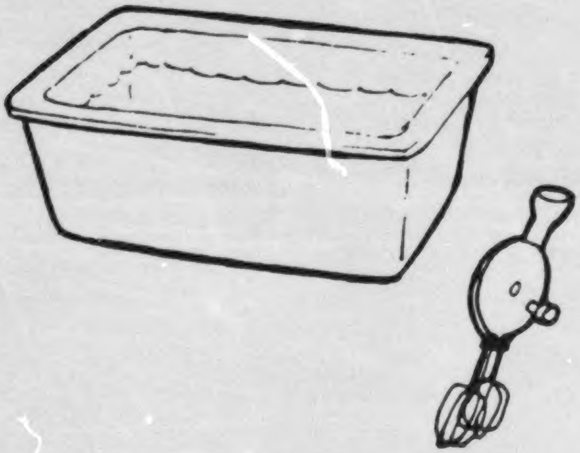


1. Select mold called a "wire."



2. Fill tub 3/4 full of warm water and shred pulp into the water while stirring the mixture.

3. Boil two tablespoons of laundry starch in two cups of water. Pour in tub and beat with egg beater.



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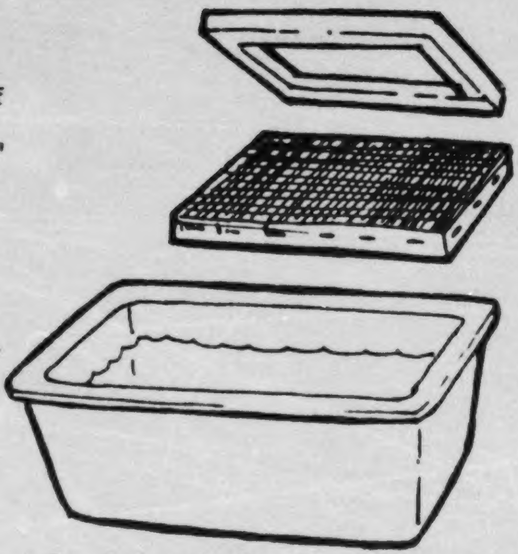
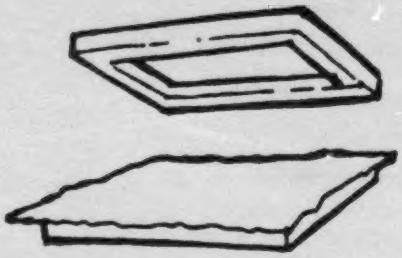
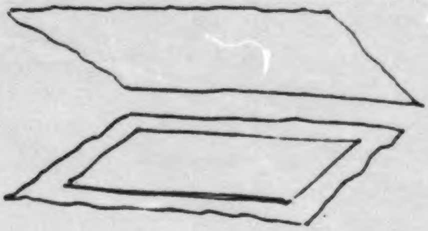
4. Insert "wire" down to the bottom of the tub. Place the wooden frame over the "wire" and pull the "wire" with frame out of the tub while in a horizontal position.



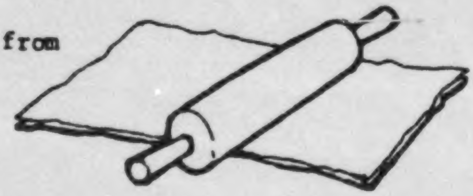


5. Separate the two mold components and place blotter paper over the "wire."

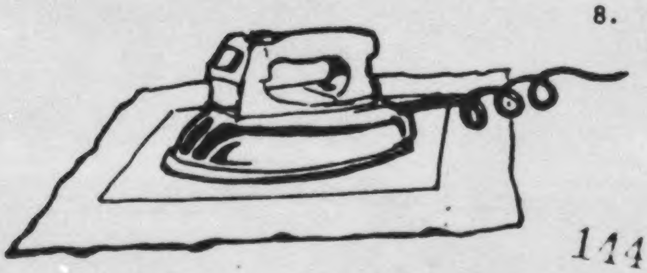
6. Pull blotter off the wire and place a second blotter over the wet paper matting. Press dry. This process may have to be repeated several additional times with additional sheets.



7. Roll out excess moisture from sheet.



8. Iron with a low heat to desired surface gloss .



INSTRUCTIONS FOR MAKING PAPER

A container, such as a dishpan, approximately 6" deep and wide enough to allow a free movement of the box and screen is necessary. Fill the pan with water and then tear apart or pulverize a small piece of the raw pulp stock which is in the kit. A little bit goes a long way, so it is best to start with a small quantity and keep checking it on the screen until the right amount of pulp is evident.

The pulp must be dissolved thoroughly in the water, and this can be done by vigorously stirring so the pulp is held in suspension in the water. The water will appear dull, dirty, and murky. When the pulp and water have been mixed to the consistency you desire, immerse the box and screen (stir immediately before immersing) into the water and shake from side to side while raising slowly. Shaking the box side to side causes the pulp to intermix (cross grain) to give strength to the sheet and also has a tendency to smooth out the pulp.

Raise the box and screen and let the water drain completely out for just a minute or so, and then separate the wood box and the screen. Be careful not to disturb the pulp which has deposited on the screen. Place the screen with the pulp between the wool pads and press gently so that the wool will absorb some of the water. Then remove the screen from the wool pad and place it between the blotting sheets and apply gentle pressure. This will remove some more water from the pulp or the paper sheet. Lay the sandwich on smooth flat surface, remove top blotter and very gently separate the screen from the pulp, leaving the pulp on the bottom blotter.

In order to dry this sheet further, put a place of blotter over the pulp. Use a hand iron or electric iron while the pulp is still between the blotters. Run the iron over the surface of the blotting paper similar to ironing clothes. To put a smoother finish on the sheet run the iron directly on the paper.

IRONING THE SHEET
OF DAMP PAPER

FORMING MATERIALS

CONTOUR LAMINATION

DESCRIPTION OF LESSON

The properties and processes of contour lamination with woods

OUTLINE OF CONTENT

I. Contour lamination - pressing wood layers, with adhesive between the layers, to desired shape with matching male/female forms until the adhesive has cured

- A. The toughness and flexural strength of laminated products far surpass solid wood counterparts. Large building curved arch rafters and lightweight furniture are examples of laminated products.
- B. Materials requirements
    1. Thin layers (veneer) allow greater contours than do heavy layers
    2. The layers must be free of knots and blemishes
    3. When the grain of each layer runs the same direction the process is called laminating, but when the grain pattern direction changes from layer to layer the process is called cross-banding

BEHAVIORAL OBJECTIVES

1. The student will compare and contrast characteristics of laminated and solid wood products.
2. The student will indicate when cross-banding is more desirable than laminating and vise-versa.
3. The student will produce a laminated salad fork comprised of two veneer layers.

DESCRIPTION OF STUDENT ACTIVITY

The student will make a salad fork by the contour laminating process.

REQUIRED READINGS, SUPPLIES, AND EQUIPMENT

[illegible]
Veneer
White vinyl glue
Waxed paper
Glue brushes
Matching wooden molds
Abrasive paper
Finishing oil
Hand screw clamps
Files

Equipment:
Band saw
Jig saw

FORMING MATERIALS

EXPLOSIVE FORMING

DESCRIPTION OF LESSON

The value of an explosive charge in forming metal will be discussed and shown.

OUTLINE OF CONTENT

I. Explosive forming - forming sheet metal into a metal cavity form with an explosive charge, usually gun powder; this is a cold forming process

- A. Tooling - a firing chamber of heavy design and a one piece molding form is required
- B. Nature of explosive formed products
  1. Largely experimental and low volume production
  2. Extremely difficult to form metals and product shapes may be formed by the sudden impact of explosive forming; sometimes not possible by other processes
  3. One side of the formed part has no tool mark off

II. Demonstrate how to form a small arrowhead of sheet copper, while explaining carefully all safety precautions

BEHAVIORAL OBJECTIVES

1. The student will indicate the value of explosive forming as compared to spinning, stamping, and casting.
2. The student will select an appropriate definition of explosive forming from a list of four alternatives.
3. The student will recite safety precautions prior to any explosive forming lab activity.
4. The student will explosive form a small arrowhead of copper.

DESCRIPTION OF STUDENT ACTIVITY

The student will explosive form a copper arrowhead key chain component.

REQUIRED READINGS, SUPPLIES, AND EQUIPMENT

Supplies:
.040" - .060" copper
Explosive forming tool
Explosive charge
Abrasive cloth for polishing
Hand lever hole making punch

Equipment:
Explosion chamber
Cloth buffer machine

FORMING MATERIALS

CASTING AND FORMING IMITATION GLASS

DESCRIPTION OF LESSON

The difficulties of glass forming and coloring will be reviewed and the development of polyester and acrylic glass synthetics will be discussed.

OUTLINE OF CONTENT

I. Forming glass - review the process discussed in the classification of materials unit

  A. Forming acrylic - the toughness, optical qualities, and good formability of acrylic at low temperatures have made it a popular material
    1. Can be formed with low cost tooling and low pressures
      (a) Mechanical draping, vacuum, and compressed air are used
      (b) Care must be taken to avoid tool mark off
      (c) Avoid scratches by handling carefully

II. Stained glass windows - review glass costs

  A. Casting polyester with colorful dyes - a high quality stained glass synthetic

  B. Product is made by casting differing batches of dyed resins. The cured slabs are broken or cut into desired shapes, arranged, and leaded together.

III. Demostrate forming acrylic for the optical lamp rear glass and casting the polyester stained glass window for the optical lamp face

BEHAVIORAL OBJECTIVES

1. The student will compare and contrast forming glass with forming acryli
2. The student will indicate advantages of synthetic stained glass.
3. The student will form acrylic by draping over a male form and will cast a synthetic stained glass window of polyester.

DESCRIPTION OF STUDENT ACTIVITY

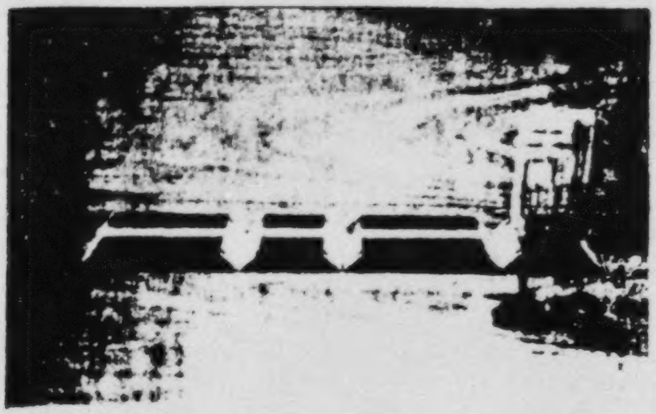
The student will produce a polyester stained glass window and an acrylic transparent window for the optical lamp.

REQUIRED READINGS, SUPPLIES, AND EQUIPMENT

Supplies:
- 1/10" - 1/8" clear acrylic sheet
- Drape forming tool
- Polyester resin with catalyst
- Stained glass window molds
- Aluminum filled epoxy
- Parting agents

Equipment:
- Oven
- Band saw

OPTICAL LAMP



OPTICAL LAMP HOUSING AND PRINTED CIRCUIT BOARD

The following activities are taken from:

Getting To Know Materials

A Materials Development Project
University of Wisconsin-Stout
Menomonie, Wisconsin 54751

Activity: Materials - I-2B

Name ______________________

Period ______________________

Sources of Materials

Materials needed: Obtain from your instructor:

1. Transparent maps of the United States.
2. Colored pens (water soluble or grease pencil).

Procedures:

1. Consult:
   a. *The National Atlas of the United States of America*, United States Department of the Interior Geological Survey, Washington D.C.
   b. or an encyclopedia
   c. or ask your librarian or resource center personnel,

   for:

   Maps

   Atlases

   that tell or show:

   1. Where material resources are found
   2. Where major groups of industries are located

2. How?? . . . . ideas

   Look in the index of the atlas or encyclopedia for such things as:

   Economic
   Business
   Manufacturing
   Transportation
   Communication
   Petroleum
   Coal
   Plastic
   Organic Fuels
   Crude Oil and Products
   Natural Gas
   Mineral & Energy Resources
   Power Production & Consumption
   Fishing and Forestry
   Rubber
   etc. . . . . .

MORE → → → → → → → →

3. The problem is: What to do with it?

   a. Choose 3 materials or material classifications you can find a map or atlas about that show the sources of those materials.

   b. Assign the materials you choose a color (of one of the colored pens).

   c. Shade or color in the areas on your map where the materials are located (Use one color & material for each transparency). Label each map telling material being shown.

   d. Choose a related industry that might use some of the materials you chose (consult index for ideas). Then shade or color the location of this industry on another transparency.

   e. Compare - by placing the materials map over the industry map, or one materials map over another materials map. See if you can find any groupings, relationships, patterns or overlaps.

   f. Take a few minutes and jot down the states or areas where you see any relationships . . . etc. Name the material and industry that you used.

   g. Submit these to your instructor.

Activity: Materials - I-1,2,3

Name ______________________________

Period ______________________________

Classification of Materials

Directions: Now that you have gone through this package and you understand something about materials:

1. Pretend you have a sample of all the different types of materials in the world piled in front of you.

   You have a large number of drawers or boxes behind you.

   You are going to store the materials in the drawers or boxes

   How would you do this?

   The problem is:

   To classify or arrange the materials in some order or system. Because with all the materials in the world we simply will not have enough boxes.

2. Make a chart, graph, or picture of your idea. Make it neat and readable.

   Everyone's idea does not have to be the same. It can be different or it can be the same. If your idea is different - good - stick with it and be ready to tell why you chose it!

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Student Evaluation

Materials

Name ______________________

Instructor ______________________

School ______________________

Directions: Answer all of the following questions to the best of your ability. The questions are written to evaluate your knowledge and understanding of the area of industrial arts covered in this package. Choose the answer which best completes the statement.

1. A good definition of the term materials, as it is used in industry, is:

   a. All of the matter on earth that has substance.
   b. Anything which is used or required to produce a product.
   c. Substances from which products are produced.
   d. Devices or apparatus necessary for doing or making something.

2. Materials used to produce a product are obtained by:

   a. Extraction from the earth
   b. Growth in plant or animal form
   c. Combination of other materials
   d. Conditioning a material to produce a new material with different properties.
   e. All of the above

3 & 4. Materials which are grown or extracted are (3)________________ and materials which are a result of combination or conditioning are (4)________________.

   a. Agricultural materials
   b. Man-made materials
   c. Natural materials
   d. Industrial materials

5. A roll of sheet aluminum is an example of a material which has been

   a. Grown
   b. Extracted
   c. Combined
   d. Conditioned
   e. Both B and D

6. The property of a material that refers to the ease with which it can be shaped mechanically is:

   a. Ductility
   b. Brittleness
   c. Impact resistance
   d. Malleability

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7. When we say a material has the physical property of ductility, we mean that:

   a. It can easily be shaped by rolling, pressing, or hammering.
   b. It has a high resistance to scratching or indentation.
   c. It can be pulled or stretched without breaking.
   d. It is easily broken or shattered.

8. A steel rod which has a high resistance to rusting is an example of which of the following properties of materials:

   a. Chemical
   b. Biological
   c. Thermal
   d. Electrical
   e. Physical

9. An automobile drive shaft must have great _____________ strength.

   a. Tension
   b. Compression
   c. Torsion
   d. Shear

10. Shear strength of a material is its ability to resist

    a. Failure under opposite loads
    b. Being cut or sheared
    c. Twisting forces
    d. Being squeezed or compressed
    e. All of the above
    f. A or B above

11. Styrofoam plastic is a good material for a disposable coffee cup because:

    a. It is ductile and has good thermal properties
    b. It is malleable and has high torsion strength
    c. It has the right electrical properties and is inexpensive
    d. It is resistant to attack by the acids in coffee and is very malleable

12. Aluminum is a good material for a lawn mower engine because:

    a. It dissipates heat well
    b. It is very resistant to wear on its load bearing surfaces
    c. It doesn't have to be painted
    d. It is so cheap and easy to obtain

13. You are asked to produce a table to be used in an electricity lab. You choose ______________ as the material for the top.

    a. Wood
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    c. Steel
    d. Aluminum

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Menomonie, Wisconsin 54751

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    Natural Gas
    Mineral & Energy Resources
    Power Production & Consumption
    Fishing and Forestry
    Rubber
    etc. . . . . .

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MORE → → → → → → → →

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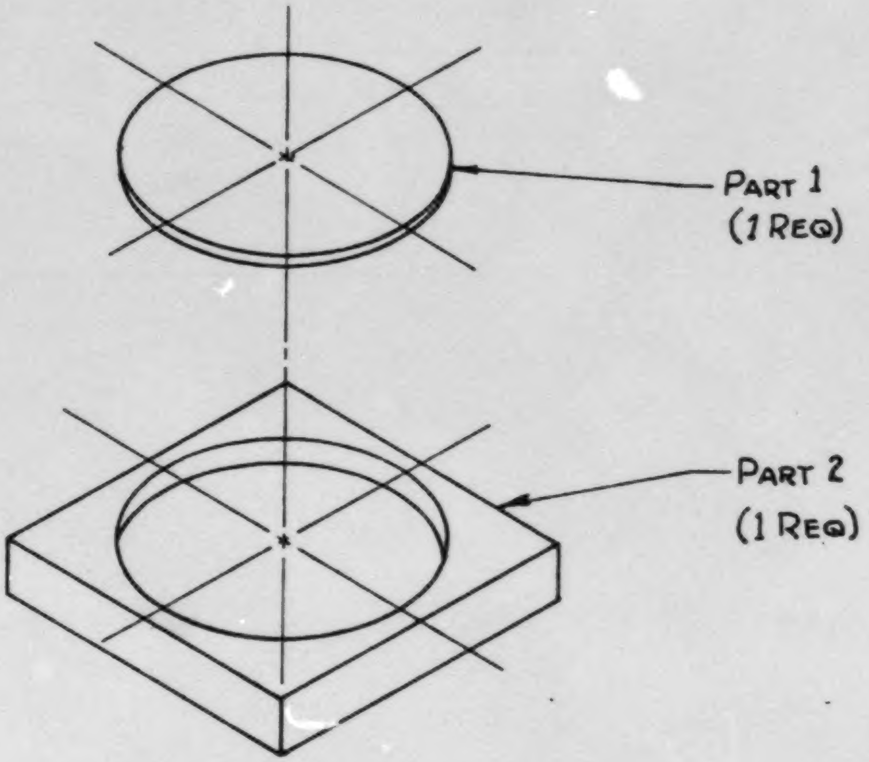
13. You are asked to produce a table to be used in an electricity lab. You choose _____________ as the material for the top.

    a. Wood
    b. Clear plastic
    c. Steel
    d. Aluminum

These activities are examples of products involving many different materials and processes. They are structured in such a fashion so as to be used for group production problems.

For further information on the source of the guides see the resource section of this book.

LEVEL I - American Industry
UNIT IV - Operating An Enterprise
Lesson 24 - Selecting a Product and Planning For Production
Student Activity Assignment Sheet #1

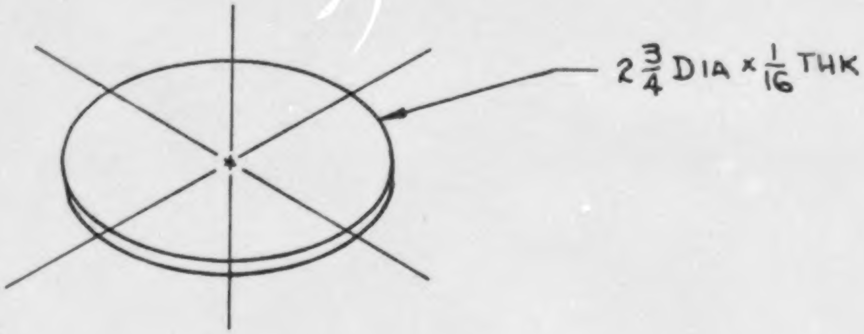


Title: Coaster	Serial No.	Sheet 1 Of 7
Company:	Model No.	
Date:	Part No.	

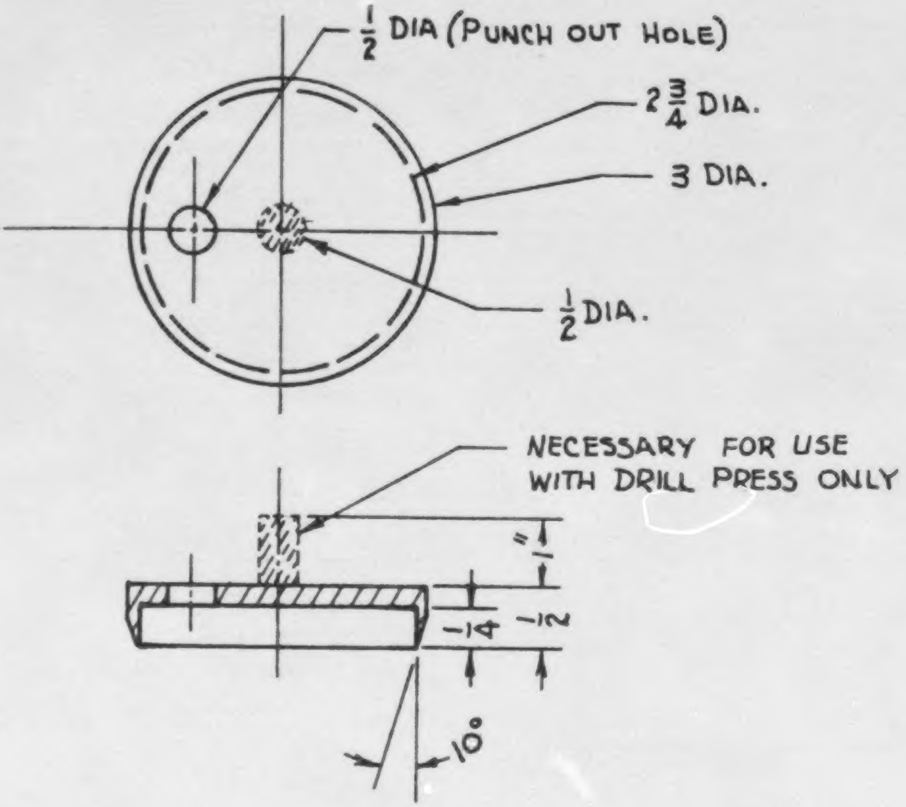
I - IV - 24 SAAS #1

PRODUCTION ORDER

	Operation	Machine	Worker	# Fin.	# Rej.	# Com
1	Die Cut Arbor or	D. Press or Vise				
2	Assemble	Hand				
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						


$2\frac{3}{4}$ DIA × $\frac{1}{16}$ THK

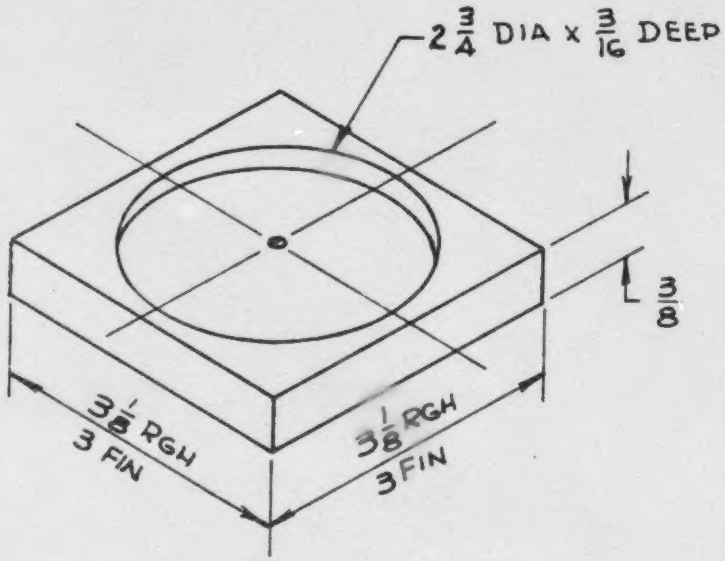
Serial No.	Sheet 2 Of 7
Model No.	Part: 1
Model Name: Coaster	Part Name: Cork Cushion


$\frac{1}{2}$ DIA (PUNCH OUT HOLE)
$2\frac{3}{4}$ DIA.
3 DIA.
$\frac{1}{2}$ DIA.
NECESSARY FOR USE WITH DRILL PRESS ONLY
1/4"
.14
.12
10°

Title: Coaster Cork Cushion Cutting Die	Serial No.	Sheet 3 Of 7
Company:	Model No.	
Date:	Part No.	

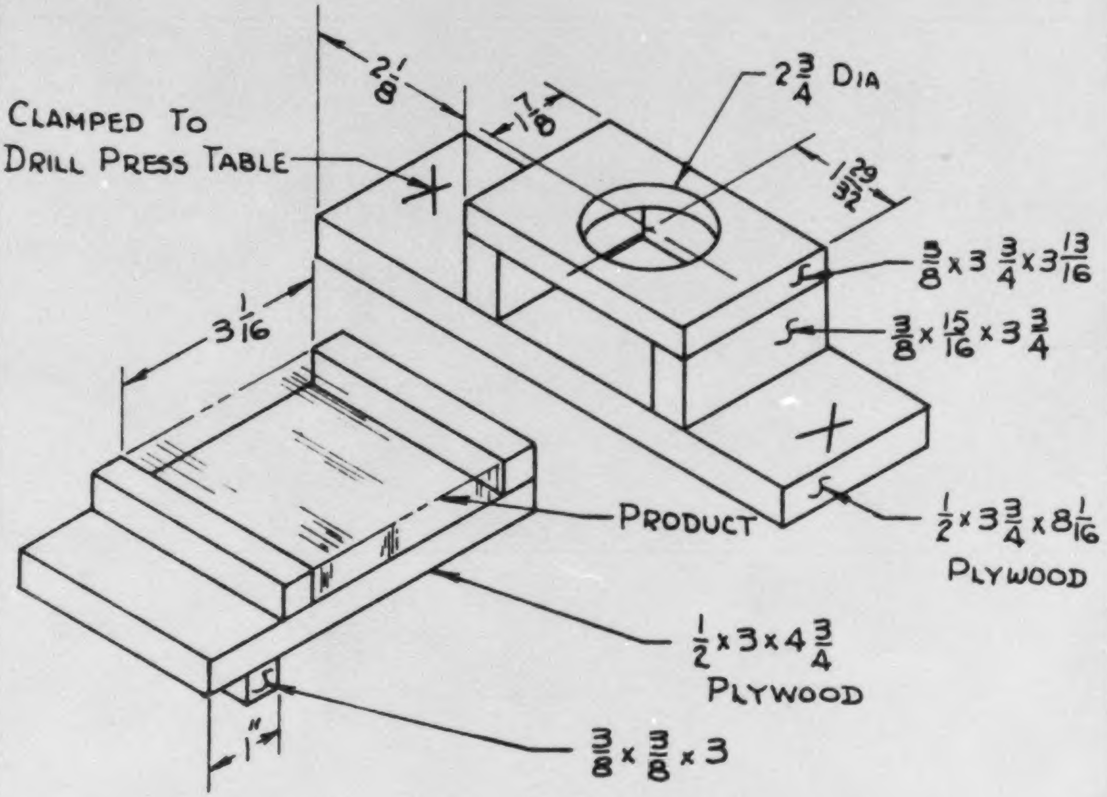
PRODUCTION ORDER

	Operation	Machine	Worker	# Fin.	# Rej.	# Com
1	Rip to 3 1/8"	B. Saw				
2	Crosscut to 3 1/8"	B. Saw				
3	Sand First Edge Sq.	B. Sander				
4	Sand to Width (3")	B. Sander				
5	Sand First End Sq.	B. Sander				
6	Sand to Length (3")	B. Sander				
7	Drill Hole	D. Press				
8	Sand Sides	B. Sander				
9	Finish Sand	Hand				
10	Finish	Hand				
11	Assemble	Hand				
12	Package	Hand				

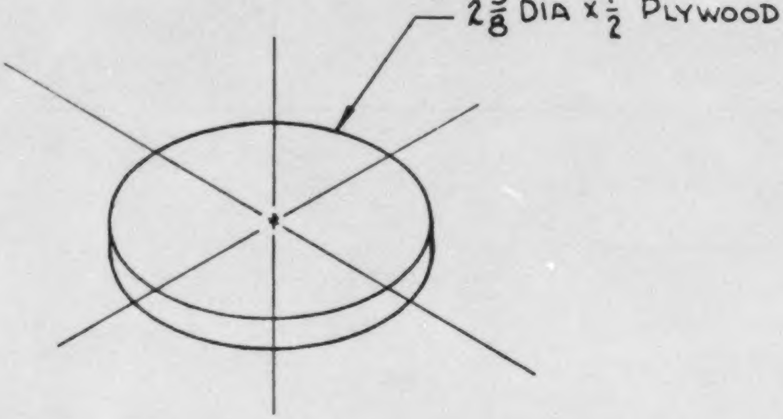

2 3/4 DIA x 3/16 DEEP
3/8
3 1/8 RGH
3 FIN
3 1/8 RGH
3 FIN

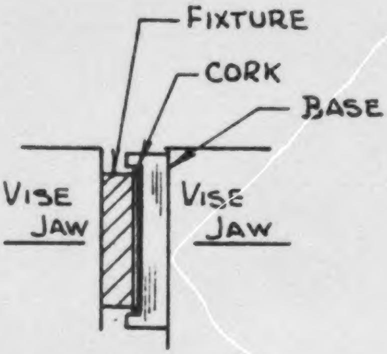
Serial No.	Sheet 4 Of 7
Model No.	Part: 2
Model Name: Coaster	Part Name: Base

[illegible] - 17 - 24 SAAS #1


CLAMPED TO DRILL PRESS TABLE
2 1/8
1 7/8
2 3/4 DIA
1 29/32
3/8 x 3 3/4 x 3 13/16
3/8 x 15/16 x 3 3/4
3 1/16
PRODUCT
1/2 x 3 3/4 x 8 1/16 PLYWOOD
1/2 x 3 x 4 3/4 PLYWOOD
3/8 x 3/8 x 3
1"

Title: Coaster Drill Press Fixture	Serial No.	Sheet 5 Of 7
Company:	Model No.	
Date:	Part No.	

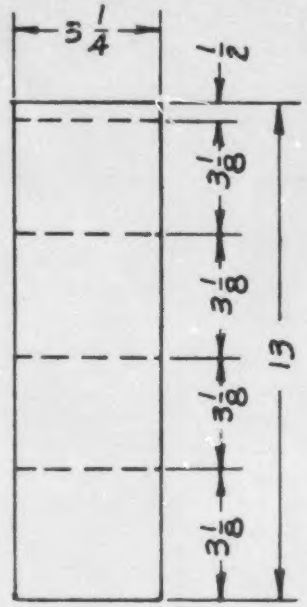

2 5/8 DIA x 1/2" PLYWOOD


FIXTURE
CORK
BASE
VISE JAW
VISE JAW

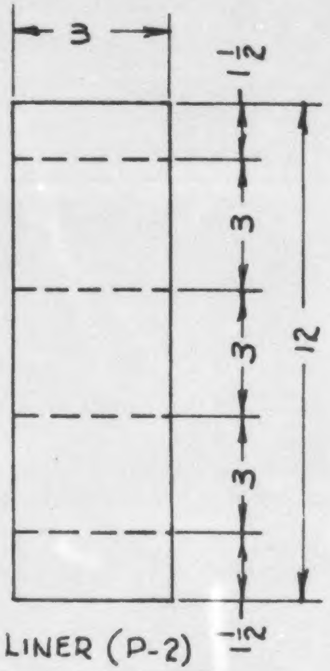
Title: Coaster Assembly Fixture	Serial No.	Sheet 6 Of 7
Company:	Model No.	
Date:	Part No.	

PRODUCTION ORDER

	Operation	Machine	Worker	# Fin.	# Rej.	# Com
1	See Corn Skewer Holder Details for Scoring, Fixture					
2	Details, Assembly Fixture, and Assembly Techniques.					
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						



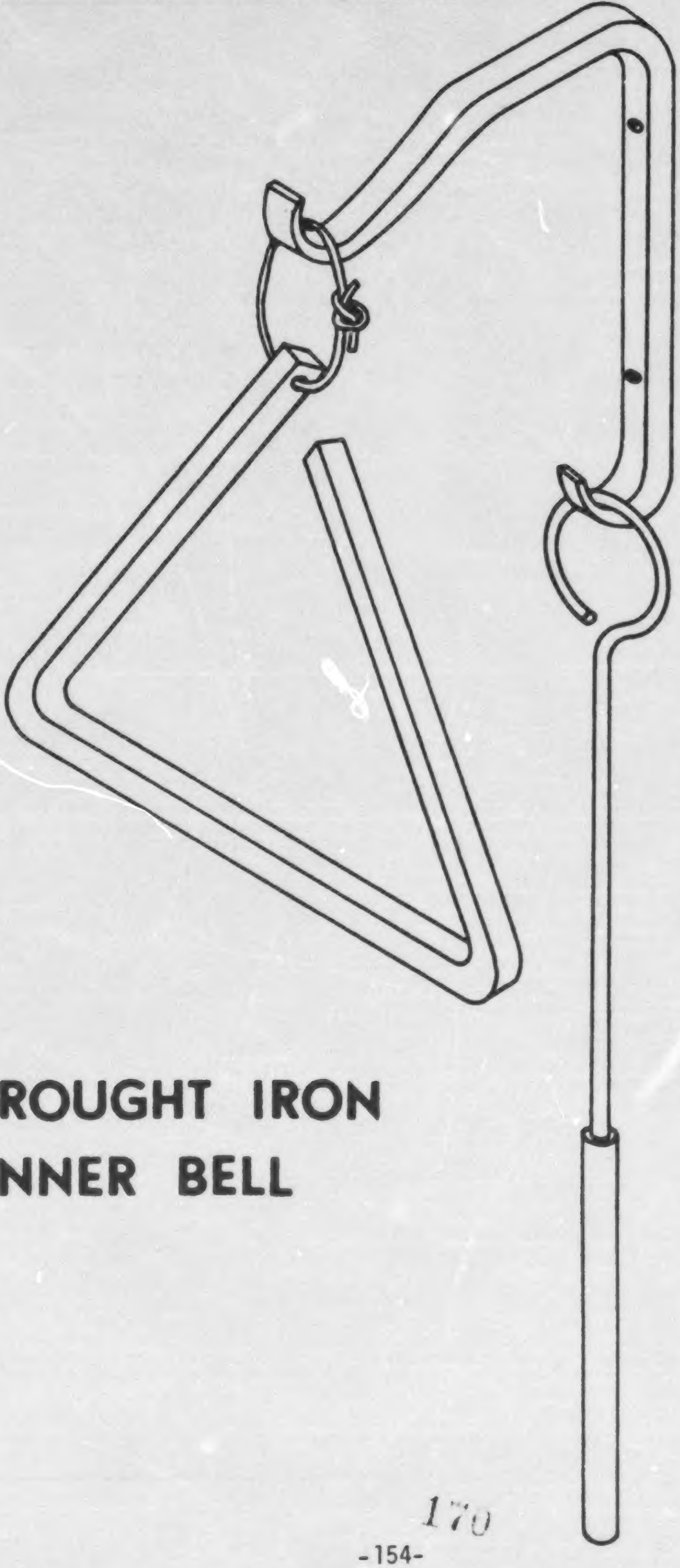
SHELL (P-1)



LINER (P-2)

Serial No.	Sheet 7 Of 7
Model No.	Part: P-1 and P-2
Model Name: Coaster Package	Part Name: Package Liner and Shell

LEVEL I - American Industry
UNIT IV - Operating An Enterprise
Lesson 24 - Selecting a Product and Planning for Production
Student Activity Assignment Sheet #4



WROUGHT IRON DINNER BELL

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I - IV - SAAS #4

WROUGHT IRON DINNER BELL

Bill of Materials

Quantity	Part	Material	Size
1	Bracket	Mild Steel	3/8" sq. x 3/8" x 12"
1	Triangle	Mild Steel	3/8" sq. x 3/8" x 20"
1	Striker Handle	Mild Steel	3/16" dia. x 10"
1	Striker	Mild Steel	3/8" dia. x 5"
1	Fastener	Rawhide	1/8" x 1/8" x 2"

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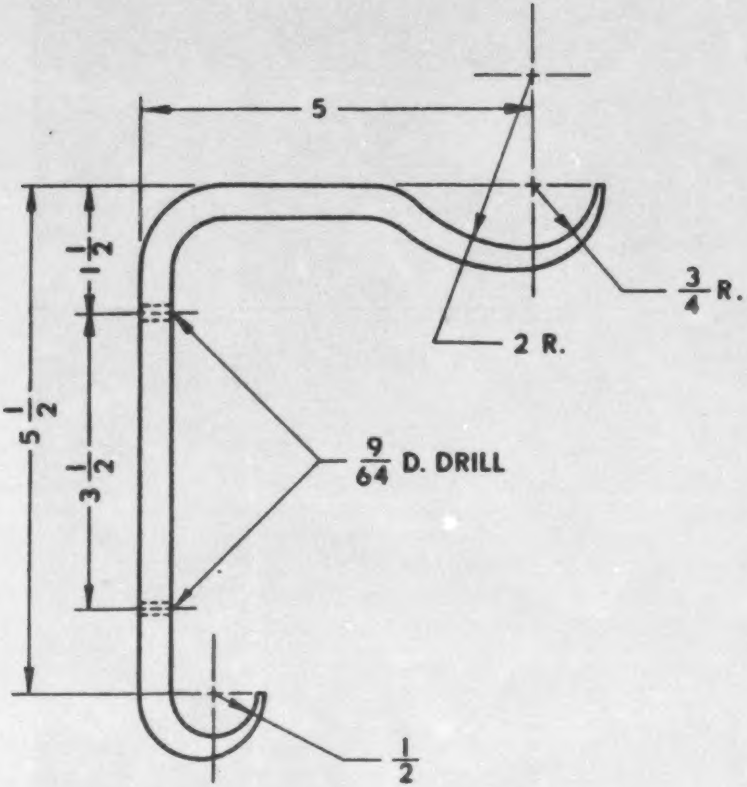
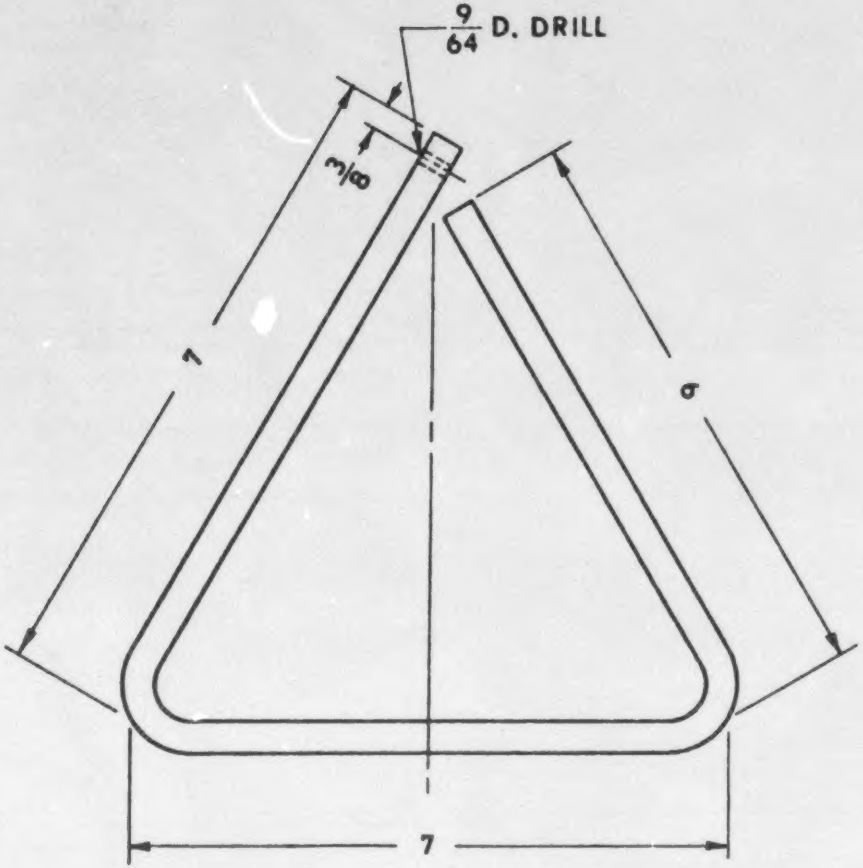

5
1 1/2
5 1/2
3 1/2
9/64 D. DRILL
3/4 R.
2 R.
1/2

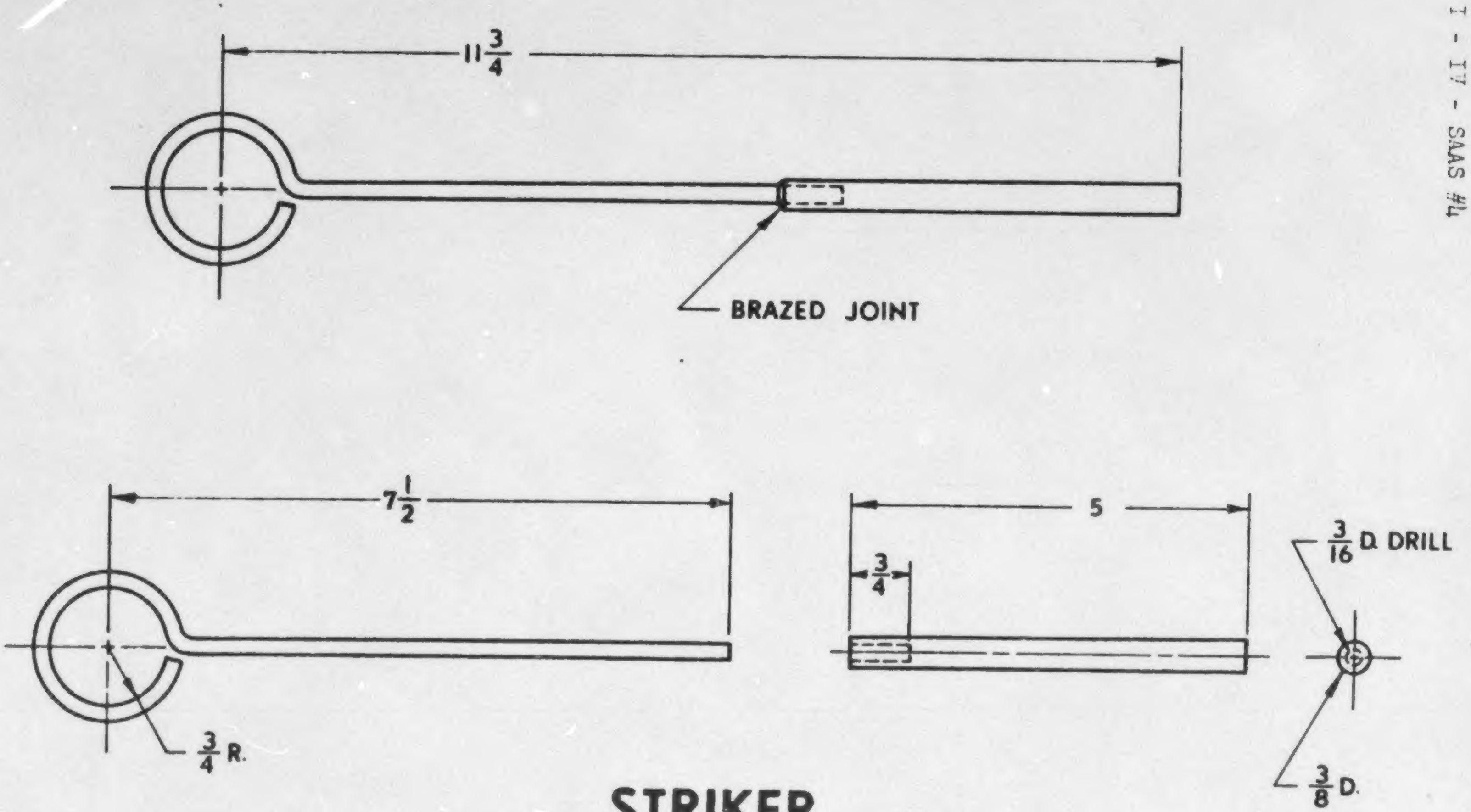
BRACKET

NOTE:
BREAK ALL SHARP EDGES.


9/64 D. DRILL
3/8
7
6
7

TRIANGLE

NOTE:
BREAK SHARP EDGES.


11 3/4
BRAZED JOINT
7 1/2
3/4 R.
5
3/4
3/16 D. DRILL
3/8 D.

STRIKER

NOTE:
BREAK ALL SHARP EDGES.

The following are some ideas that could be used as possible activities to be used in the material testing area.

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ACTIVITIES FOR THE AREA OF MATERIALS

1. Materials Research -
   Students contact companies and bring in samples of materials.
   Start a materials library that can be used by the students in the future.
   Students can mount the materials and file a 3 X 5 card showing the specifications and utilization of the materials.

2. Sandwich structure showing the strength of paper.
   Students are given three sheets of paper to form a sandwich structure that has air space in the center. Upon completion the structure, by placing a board on top, should hold the weight of the instructor. Students should analyze why the structure will distribute the instructor's weight and not collapse.

3. Experiment with RTV (silastic rubber).
   Sample one pint cans available from Dow Chemical, Midland, Michigan if letter is sent on school stationery and purposes stated.
   Two types are available, quick-acting and slow-acting.
   Application: sealing, mold making, casting. Will withstand molten material up to 600° F.

4. Experiment with expanded foams.
   Sample cans available from almost any company that makes the foamed materials.
   Test for resistance against pressure.
   Test acoustical ability.
   Test as an insulative material.

5. Tensile testing.
   Use small spring loaded tensile testers to test light weight materials with a low strength capacity.
   These small testers are available, ususally, in physics labs.

6. Compression testing of materials on an arbor press, or if hydraulic and/or pneumatic equipment are available make your own testing equipment.

7. A transister as a functional material.
   Show how when input is applied that output is changed due to the characteristics of the material.
   Take a transistor apart and show the materials.

8. Solar cells as functional material.
   Kits available from Bell Telephone Company
   Show how solar cells are affected by using different shading materials.

9. Experiment with different types of textiles.
   Contact Burlington Industries, Inc., Greensboro, North Carolina for booklet Textile Fibers and Their Properties.

10. Show the different service properties of materials as shown on materials model.

11. Test materials under different weathering conditions.

12. Test bending strength of materials.

13. Show how a chip is formed when a piece of material is cut.

14. Get library to subscribe to the magazine : Materials in Design Engineering.

MATERIALS

The following material test must be completed before the end of the semester.

1. Tensile test on six (6) different types wood. Parallel to the grain.
2. Tensile test on three (3) different types of metal.
3. Tensile test on three (3) other materials.
4. Compression test on six (6) different types of wood, three (3) parallel to the grain and three (3) perpendicular to the grain.
5. Compression test on three (3) other materials.
6. Bend test on three (3) different materials.
7. Shear test on three (3) different materials.
8. Shear test on three (3) different types of fasteners.
9. Moisture test on wood.
10. Hardness test on six (6) different materials. Use both Brinell and Shore "A".
11. Alloy detector on three (3) different metals.
12. Shear test on three (3) different adhesive joints.
13. Endurance test on any one material.
14. Weathering test on any one material.
15. Effect of temperature on six (6) different materials.
16. Electrical conductivity of three (3) different materials.
17. Microscope analysis of six (6) different materials.
18. Test for three (3) different processing characteristics.
19. Chart a stress--strain curve for one tensile test on metal.

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STUDENT PLAN SHEET

ACTIVITY TITLE Concrete Foot

NAME ____________

TOTAL COST ____________

PERIOD ____________

CONTENT AREA

PROCESSES

FORMING ✓

SEPARATING ____________

COMBINING ✓

CONDITIONING ____________

FINISHING ____________

MATERIALS

METALLIC ____________

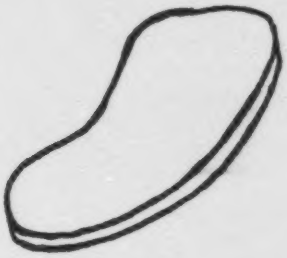
CERAMICS ✓

POLYMERS ____________

FIBEROUS ____________

COMPOSITES ✓

DRAWING



MATERIAL

Cement

Sand

Gravel

TOOLS AND EQUIPMENT

Metal stepping stone form, mixing box, shovel, wooden float and finishing trowel, mixing hoe

PROCEDURES

1. Make sure form is bolted together properly and place on a flat oiled flywood board.
2. Measure 3 parts sand, 3 parts gravel and 1 part cement in mixing box and thoroughly mix. Gradually add small amounts of water, mixing thoroughly until a medium consistency is reached. (Like a thick milkshake.)
3. Pour mix into mold and strike off level with strike board, work with wooden float.
4. As the concrete begins to harden (approximately 30-45 minutes) complete final troweling with steel trowel.
5. After the concrete has cured overnight, remove the form and handle with care until completely cured (7 to 10 days)
6. CAUTION: DO NOT WORK CONCRETE WITH HANDS, AS THIS WILL CAUSE THE SKIN TO CHAP AND DRY OUT.

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STUDENT PLAN SHEET

ACTIVITY TITLE Hot Pad Holder (plastic) NAME ____________

TOTAL COST ____________ PERIOD ____________

CONTENT AREA

PROCESSES

FORMING ____________

SEPARATING ✓

COMBINING ✓

CONDITIONING ____________

FINISHING ✓

MATERIALS

METALLIC ____________

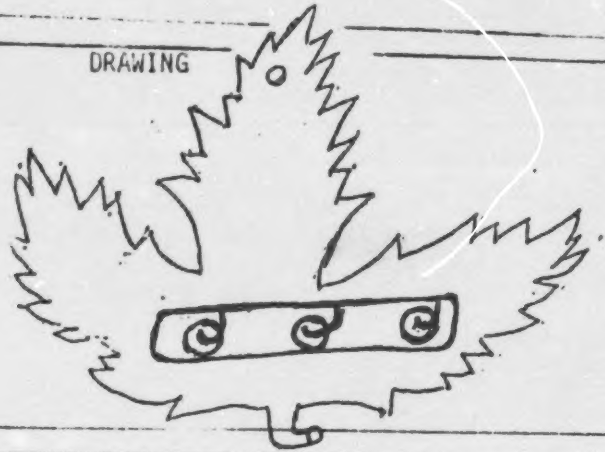
CERAMICS ____________

POLYMERS ✓

FIBEROUS ____________

COMPOSITES ____________

DRAWING



MATERIAL

Plexiglas 1/16 to 1/8

Cup Hooks

Plastic Glue
(Laminating Cement)

TOOLS AND EQUIPMENT

Jig saw (fine tooth for smoother edges,)drill & bit (drill press,) hand drill, file (fine tooth), sand paper - medium & fine, buffer & plastic buffing compound

PROCEDURES

1. Draw pattern (or your own design) on backing paper of plastic.
2. Cut out leaf (or other design) with jig saw.
3. Cut out plastic base for cup - hooks (approx 5/8" x 3").
4. File and/or sand edge of cup hook base (not necessary to polish edge of leaf).
5. Buff edge of base.
6. Locate & glue base to leaf.
7. Drill hole for hanging leaf (about 5/32") and cup hooks)

   Ethelene dichloride can soften plastic to screw in cup hooks easier.

STUDENT PLAN SHEET

ACTIVITY TITLE Clearcast Casting

NAME ____________

TOTAL COST ____________

PERIOD ____________

CONTENT AREA

PROCESSES

FORMING ✓

SEPARATING ____________

COMBINING ____________

CONDITIONING ____________

FINISHING ____________

MATERIALS

METALLIC ____________

CERAMICS ____________

POLYMERS ____________

FIBEROUS ✓

COMPOSITES ____________

DRAWING

MATERIALS

Mold, Casting Resin,

Catalyst,

Dyes

TOOLS AND EQUIPMENT

PROCEDURES

1. Select or make a mold.
2. Clean mold.
3. Fill mold with water and pour into cup to see how much resin is needed. Dry the mold.
4. Select dye colors.
5. Pour amount of casting resin needed into cup or cups. Pour with spout of gallon container up. Clean spout before replacing lid.
6. Add dye color.
7. Add 4 drops of catalyst to each ounce of resin. No more - if too much is added, it will burn up the mold.
8. Stir thoroughly.
9. Pour into mold.
10. Let set overnight before removing.
11. Break out of mold and clean mold for the next guy or girl.
12. Every casting made must be mounted or fixed in some way for display or use.

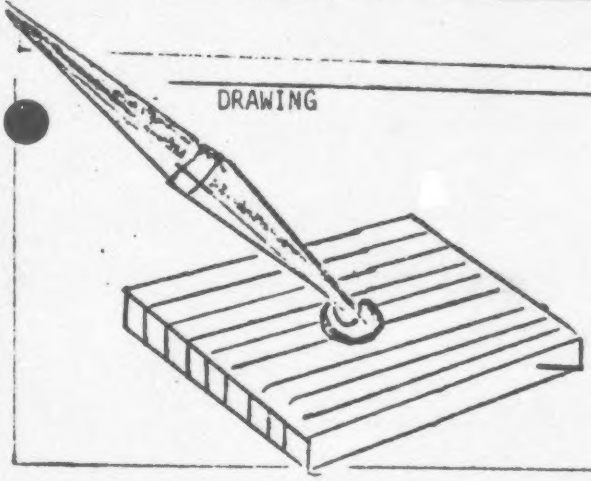
STUDENT PLAN SHEET

ACTIVITY TITLE Laminated Pen Set
NAME
TOTAL COST
PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING	✓	POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

Acrylic

Pen

TOOLS AND EQUIPMENT

Bandsaw, stationary belt sander, buffer, ruler, square and acetone

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PROCEDURES

1. Decide on the shape of the pen set (circular, square, rectangular, etc.).
2. Choose the colors of plastic to be used and mark out your saw lines.
3. Use the bandsaw or jigsaw and saw the material to shape.
4. Remove the protective paper from the acrylic. Remove any sticky residue from the paper with a small rag dampened with acetone.
5. Glue the pieces of plastic together with laminating cement and clamp with a screw clamp and let set overnight. There are special brushes for the laminating cement in the finishing room. Clean the brush in acetone when you are done.
6. Draw out the final shape of the pen set and saw to shape with the band saw.
7. Use the stationary bolt sander and sand the surfaces of your laminated block of plastic if they need it.
8. Use 220 grit wet-dry abrasive paper and sand the surfaces further.
9. Polish the project with the buffer and polishing compound.
10. Locate where the pen swivel is to be located and drill a 1/8" hole with the drill press. Countersink the bottom of this hole so that the head of the swivel mounting screw is recessed.
11. Attach the pen swivel and funnel to the laminated base and you are done with your project.

STUDENT PLAN SHEET

ACTIVITY TITLE Fiberglass Clipboard

NAME ______

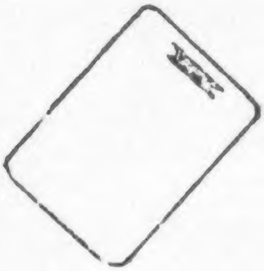
TOTAL COST ______

PERIOD ______

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	
SEPARATING		CERAMICS	
COMBINING	✓	POLYMERS	✓
CONDITIONING		FIBEROUS	✓
FINISHING	✓	COMPOSITES	✓

DRAWING



MATERIAL

1 10 X 14 Decorator Cotton

1 3/4 oz. Reinforcing mat

1 1½ oz. " "

1 1 oz. Decorator mat

TOOLS AND EQUIRMENT

PROCEDURES

PHASE I

1. MOUNT 12 1/2 X 9 PLYWOOD FORM PROVIDED AND TURN UNTIL SECURE, SAND LIGHTLY .
2. TURN EXHAUST FAN ON AND POUR 3 OUNCES OF POLYESTER RESIN INTO MIXING CUP, ADD 9 DROPS OF CATALYST AND MIX THOROUGHLY USING MIXING STICK PROVIDED.

3. USING THE CLEAN BRUSH, SPREAD THE RESIN OVER THE FACE AND EDGE OF THE PLYWOOD. ALLOW TO DRY. CLEAN BRUSH FOLLOWING THE DIRECTIONS ON WALL CHART.

PHASE II

1. USING A 1/4 SHEET OF #400 OR #600 WET OR DRY ABRASIVE PAPER, SAND SURFACE WHICH WAS COATED. OBSERVE LOOP #S77B CLOSELY.
2. BUFF TO A HIGH POLISH, USING THE BUFFER. CARE SHOULD BE TAKEN NOT TO BURN THE SURFACE.
3. APPLY 2 COATS OF WAX AND BUFF TO A HIGH MIRROR FINISH.
4. USING A CLEAN BRUSH, APPLY A LIGHT COAT OF POLY VINYL ALCOHOL RELEASE. CLEAN BRUSH BY RINSING IN WARM WATER. THE P.V.A. IS A WATER SOLUABLE PLASTIC RELEASE.

PHASE III - THIS STEP TAKES THE COMPLETE PERIOD.

1. COAT PREPARED MOLD, USING 6 OUNCES OF RESIN AND 18 DROPS OF CATALYST.
2. LAY DECORATOR COTTON DOWN AND STIPPLE WITH BRUSH, WORKING FROM CENTER TO THE OUTSIDE. THIS REMOVES THE TRAPPED AIR.
3. ADD 1ST REINFORCED FIBERGLASS MAT. AND SATURATE WITH RESIN STIPPLING FROM CENTER OUT.
4. ADD 2ND LAYER OF FIBERGLASS MAT, SATURATE & STIPPLE.
5. ADD 3RD LAYER USING FIBERGLASS CLOTH AS A FINISH LAYER AND REPEAT ABOVE STEP.
6. CLEAN BRUSH AND CLEAN UP IMMEDIATE AREA.

PHASE IV

1. WHEN THOROUGHLY DRY, REMOVE FROM MOLD AND TRIM USING PROCEDURES SHOWN IN STERLING LOOP #S77E, REMOVING FROM MOLD, FINISHING.

2. MARK, DRILL AND MOUNT CLIP FOR YOUR COMPLETED BOARD.

3. CONGRATULATIONS, YOU NOW KNOW HOW TO PREPARE A MOLD, AND WORK WITH FIBERGLASS REINFORCED PLASTIC.

4. ADD 2ND LAYER OF FIBERGLASS MAT, SATURATE & STIPPLE.
5. ADD 3RD LAYER USING FIBERGLASS CLOTH AS A FINISH LAYER AND REPEAT ABOVE STEP.
6. CLEAN BRUSH AND CLEAN UP IMMEDIATE AREA.

PHASE IV

1. WHEN THOROUGHLY DRY, REMOVE FROM MOLD AND TRIM USING PROCEDURES SHOWN IN STERLING LOOP #S77E, REMOVING FROM MOLD, FINISHING.

2. MARK, DRILL AND MOUNT CLIP FOR YOUR COMPLETED BOARD.

3. CONGRATULATIONS, YOU NOW KNOW HOW TO PREPARE A MOLD, AND WORK WITH FIBERGLASS REINFORCED PLASTIC.

STUDENT PLAN SHEET

ACTIVITY TITLE Screw Driver

NAME ____________________

TOTAL COST ____________________

PERIOD ____________________

CONTENT AREA

PROCESSES

FORMING ✓

SEPARATING ✓

COMBINING ____________________

CONDITIONING ____________________

FINISHING ✓

MATERIALS

METALLIC ✓

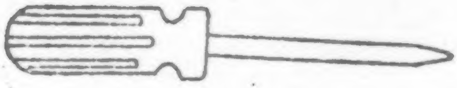
CERAMICS ____________________

POLYMERS ✓

FIBEROUS ____________________

COMPOSITES ____________________

DRAWING



MATERIALS

4" X 1/8" Drill Rod

Polyethelene Pellets

TOOLS AND EQUIPRMENT

Hacksaw

Mill=file, 12" Ruler

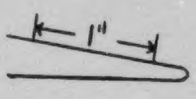
Ballpeen Hammer

Screwdriver Handle Die

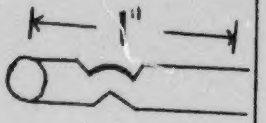
Injection Molder

PROCEDURES

1. Shear off 4" piece 1/8" drill rod with small bolt cutter hanging near towel dispenser in metals area.
2. Hammer one end to the taper of a screw driver blade with a medium weight ball peen hammer. This should be about a 1" taper.



3. File the sides of the taper to the blade shape of a screwdriver.
4. File taper to right thickness using a mill file.
5. Notch and flatten handle end for about an inch, so that blade will grip into plastic handle.



STUDENT PLAN SHEET

ACTIVITY TITLE Napkin Holder

NAME

TOTAL COST

PERIOD

CONTENT AREA

PROCESSES

FORMING ✓

SEPARATING

COMBINING

CONDITIONING

FINISHING

MATERIALS

METALLIC

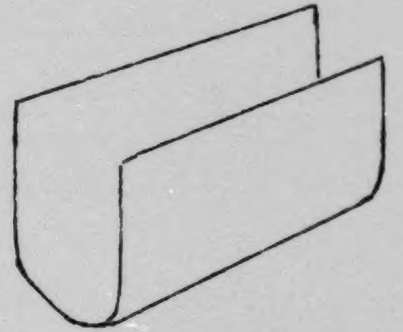
CERAMICS

POLYMERS ✓

FIBEROUS

COMPOSITES

DRAWING



MATERIAL

1/8" Acrylic Plastic 4" wide, 8" long

TOOLS AND EQUIPMENT

Scribe

T square

Strip heater

PROCEDURES

1. Cut out a piece of 1/8" acrylic plastic 4" wide & 8" long, using a copeing saw or back saw, or scroll saw.
2. Sand edges smooth by using a 250, 400 grit abrasive paper.
3. Polish each edge on the buffing machine being careful not to burn the edge.
4. Along each 8" side scribe a light mark 3" in from each outside edge. This will be your fold line.
5. You are now ready to remove the protective paper from the acrylic plastic. Lay the flat 4 x 8 piece across the strip heater elements making sure it is square and matches the scribe marks you placed along the 8" edge.
6. Allow the strip heater to warm up, then place your plastic on the strip heater.
7. Observe the plastic. You will notice that the heat from the element softens the material and you will see two lines towards the outside edges of the heated area. The material is now ready to bend.
8. Remove from heater and using a tri square as a guide, bend edge to a 90° angle. Be careful not to touch the hot surface, as this will mark the surface. Repeat this procedure to make other angle. Turn off strip heater.
9. Congratulations! You now have completed a handy napkin holder.

STUDENT PLAN SHEET

ACTIVITY TITLE Duck Set

NAME

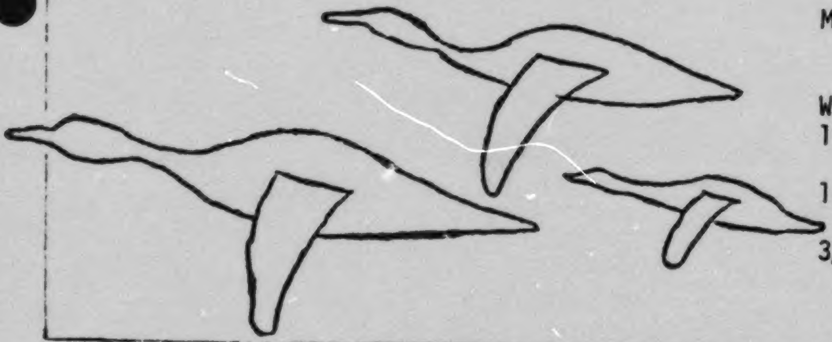
TOTAL COST

PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING	✓	POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

Western Red Cedar
1 pc. ½ X 6 X 18

1 pc. .013" 6 X 6" brass

3/4" nails

TOOLS AND EQUIPMENT

Handsaw
Tinsnips
Bandsaw
wood rasps
Surform file

Templates
Ballpeen hammer
Hand drill
Screwdriver
1/8" iron drill

Belt sander
Oxy-acetylene torch

PROCEDURES

1. Select lumber and cut to stated size - handsaw.
2. Position templates, mark outline, and cut out on bandsaw.
3. File to desired shape. Round edges as desired. Belt sander may be used.
4. Sand to remove file marks and finish with danish oil. Surface may be burned with torch if you desire this effect. Shop model is done this way.
5. Select brass or copper (see instructor) and cut to stated size. Use tinsnips.
6. Position wing templates and mark outline.
7. Cut out wings with tin snips or torch.
8. Peen wings on top surface if desired.
9. Solder 3/4" brads on back of wings.
10. Polish with steel wool and finish with gloss clear acrylic.
11. Nail wings to wood and attach hanger to back. Make hanger out of tin plate.

STUDENT PLAN SHEET

ACTIVITY TITLE Owl

NAME

TOTAL COST

PERIOD

CONTENT AREA

PROCESSES

FORMING

SEPARATING ✓

COMBINING

CONDITIONING

FINISHING ✓

MATERIALS

METALLIC ✓

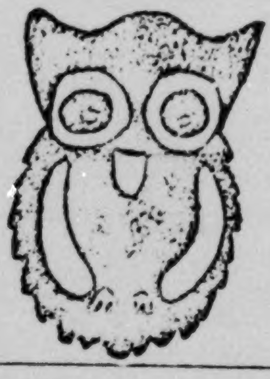
CERAMICS

POLYMERS ✓

FIBEROUS

COMPOSITES

DRAWING



MATERIAL

1 1 X 12" X 16" Western red cedar

1 .013" 8 X 8½" Brass

13 #18 3/4" Wire nails

2 #5 ½" R.H. Screws

1 24 gauge 12" Copper wire

TOOLS AND EQUIPMENT

24" Scale
Handsaw
Bandsaw
or Scroll saw
Router
Bit #5096
Rasp
Danish Oil

Oxy-acetylene torch
wire wheel
screw driver
side cutter
pliers
tinsnips
soap stone
solder gun

needle nose pliers
steel wool
clear lacquer

PROCEDURES

1. Cut one piece of western red cedar 12" x 16" with handsaw.
2. Trace owl pattern on wood.
3. Cut outline on bandsaw or scroll saw.
4. Cut feather lines with router and bit #5096.
5. Shape contour of owl with wood rasp.
6. Burn wood surface with oxy-acetylene outfit.
7. Brush charred wood with foxtail, wire brush or wire wheel.
8. Finish wood with danish oil. Instructions in finish area.
9. Attach 2-1/2" x #5 R.H. wood screws on back of owl.
10. Connect a wire to both screws, tighten and tie securely.
11. Cut a 9" x 9" piece of .013" brass with tin snips.
12. With soap stone, draw these pieces on the brass, 2 eyes, 2 wings, 2 feet, 1 nose.
13. With #0 welding tip on oxy-acetylene torch, cut out metal parts.
14. Solder one or two 3/4" wire brads on back side of each brass part.
15. Clean finished side of brass with steel wool.
16. Spray finished side with clear lacquer.
17. Locate brass parts in proper position and attach by pushing nails into the wood.

STUDENT PLAN SHEET

ACTIVITY TITLE Laminated Candle Holder

NAME ____________

TOTAL COST ____________

PERIOD ____________

CONTENT AREA

PROCESSES

FORMING ____________

SEPARATING ✓

COMBINING ✓

CONDITIONING ____________

FINISHING ✓

MATERIALS

METALLIC ____________

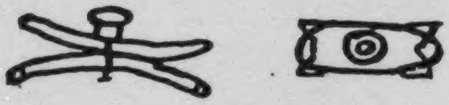
CERAMICS ____________

POLYMERS ✓

FIBEROUS ____________

COMPOSITES ____________

DRAWING



MATERIAL

14 - 1/28" thick veneer

3 X 6" 1 Kosy Creation

Candle cup 2 pcs.

Garnet paper, White glue

1 - 3/4" long 6-32 Machine Screw & nut

TOOLS AND EQUIPMENT

Laminating Jig form

Metal Templates

Saran Wrap (or sim. plastic)

Band saw

Glue Clamps

Drill Press

½" Drill bit

Disc Sander

Screwdriver

PROCEDURES

1. Obtain 7 pieces of Veneer. (size stated)
2. Smear glue on all but outer faces.
3. Protect outer faces with Saran Wrap.
4. Place in Jig Form for gluing.
5. Clamp tightly with clue clamps. Caution: make sure Veneers slip evenly from center of curve.
6. Let air dry in clamped form for 8 hours.
7. Remove from clamped form.
8. Smooth one edge of Veneer lamination against disc sander
9. Saw second edge parallel on band saw 2½" wide.
10. Repeat steps 1-9 with remaining 7 pieces.
11. Trace top template pattern on one lamination.
12. Trace bottom template pattern on other lamination.
13. Form top lamination convex curve with disc sander.
14. Form bottom lamination concave curve with drum sander.
15. Prepare laminations with abrasive paper.
16. Mark center of each lamination for 1/8" hole.
17. Drill each lamination & base of Kosy Cup.
18. Danish oil laminations. Spray paint Kosy Cup.
19. Fasten laminations & Kosy Cup together with machine screw & nut.

STUDENT PLAN SHEET

ACTIVITY TITLE Tie Holder

NAME

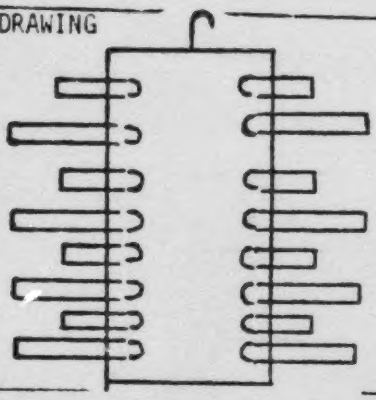
TOTAL COST

PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

Hardwood 3/4" X 2½" X 9"

¼" Dowel 8 pc. 4½"
8 pc. 2½"

1/8" Braze rod 4"

TOOLS AND EQUIPMENT

Bandsaw

Steel Scale

Sandpaper

Drill Press

¼" Twist Drill

Danish Oil

PROCEDURES

1. Cut piece of hardwood 3/4" x 2-½" x 9.
2. Layout 8 center lines on each side 1" apart.
3. Drill 1/4" holes, 1/2" deep.
4. Sand hardwood.
5. Cut 8 pieces of 1/4" dowel, 2-½" long and 8 pieces 4-½" long.
6. Sand dowel and glue as illustrated.
7. Finish with Danish oil.
8. Drill 1/8" hole in top.
9. Bend 1/8" dia. x 4" brazing rod into hook and install.
10. Install plastic ends on dowels.

STUDENT PLAN SHEET

ACTIVITY TITLE Wood Cannon

NAME ______

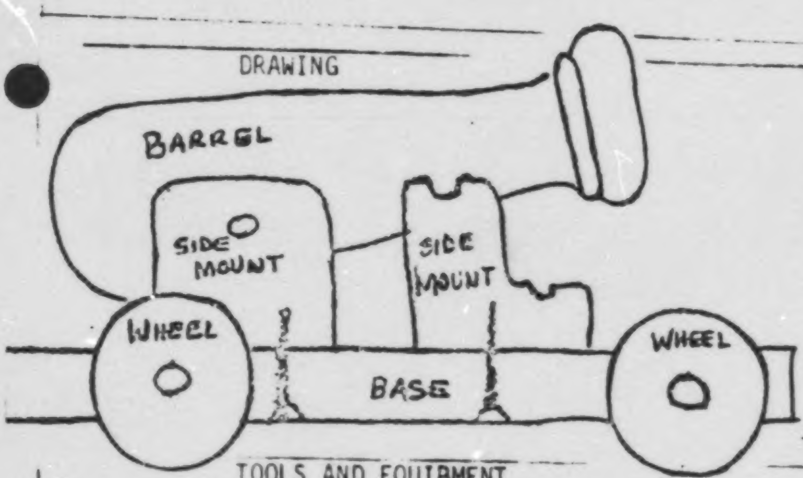
TOTAL COST ______

PERIOD ______

CONTENT AREA

PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

8 .031" X ½" X 2" Brass for trim
1 4" X 4" X12" Fir
1 3/4" X 8" X 15" Western Red Cedar
4. pcs. 3/4" X 4" X 4" " " "
4 pcs. 3/4" X 3" X 3" " " "
1 3/8" X 12" Dowel
4 8 X 1¼ F.H.S. Wood Screws

TOOLS AND EQUIPMENT

Handsaw
Wood Lathe
Framing square
Bandsaw
Drill Press
Oxy-acetylene Outfit
Screw driver

Wire wheel
1 ½" bit
3/8" bit
1¼ X 8 Screw Mate
Awl
Tin Snips
Hammer

PROCEDURES

1. Cut out stock to rough size.
2. Turn barrel to desired proportion on lathe.
3. Drill 1-½" hole 4" deep in front of barrel.
4. Cut side mounts to shape. (See model or sketch)
5. Drill 3/8" holes in 2 side mounts to hinge barrel.
6. Cut & drill four wheels.
7. Apply burned finish to the parts cut out so far.
8. Apply oil finish to these parts.
9. Assemble side mounts to base using barrel to space them. Screw from bottom side of base. Use screwmate.
10. Drill through side mounts into barrel for hinge.
11. Cut out brass trim.
12. Punch holes with awl.
13. Install trim on wheels with brass escutcheon pins.
14. Drill through wheels into base.
15. Install wheels and barrel with 3/8" dowel.
16. Oil finish again.

STUDENT PLAN SHEET

ACTIVITY TITLE Pen Holder

NAME

TOTAL COST

PERIOD

CONTENT AREA

PROCESSES

FORMING

SEPARATING ✓

COMBINING

CONDITIONING

FINISHING ✓

MATERIALS

METALLIC

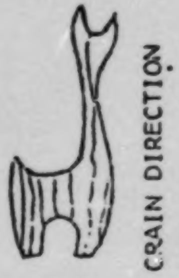
CERAMICS

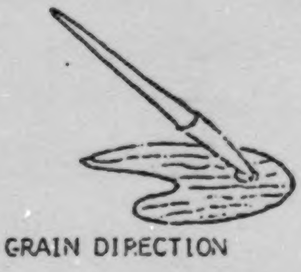
POLYMERS ✓

FIBEROUS

COMPOSITES

DRAWING





MATERIAL

Wood Cat 1" X 4" X 12" Mahogany

" Pen Holder 1" X 4" X 6"

TOOLS AND EQUIPMENT

Bandsaw

Jig saw

Halfround sureform rasp

Halfround and round bastard file

Coarse and Medium sand paper

Danish Oil

400 Wet or Dry abrasive paper

Cross Cut Saw

9/64" Drill

PROCEDURES

1. Choose sculpture shape.
2. Take sheet metal pattern from display to lumber storage.
3. Select wood which will fit pattern and leave very little waste.
4. Trace pattern on wood.
5. Cut off size of stock needed. Beyond this step you must be checked out on each power machine you need to use.
6. Cut out shape using jigsaw or bandsaw.
7. Shape sculpture with sureform tool and bastard files.
8. Sand out file marks, start with coarse to fine.
9. Sand on oil finish.
10. Wipe with cloth to polish.

ATTACHING PEN HOLDER

1. Drill hole for pen mount with 9/64 drill.
2. Counterbore so that 1/3" of screw extends through free form block.
3. Screw on pen holder.

STUDENT PLAN SHEET

ACTIVITY TITLE Woodpecker

NAME

TOTAL COST

PERIOD

CONTENT AREA

PROCESSES

FORMING

SEPARATING ✓

COMBINING ✓

CONDITIONING

FINISHING ✓

MATERIALS

METALLIC ✓

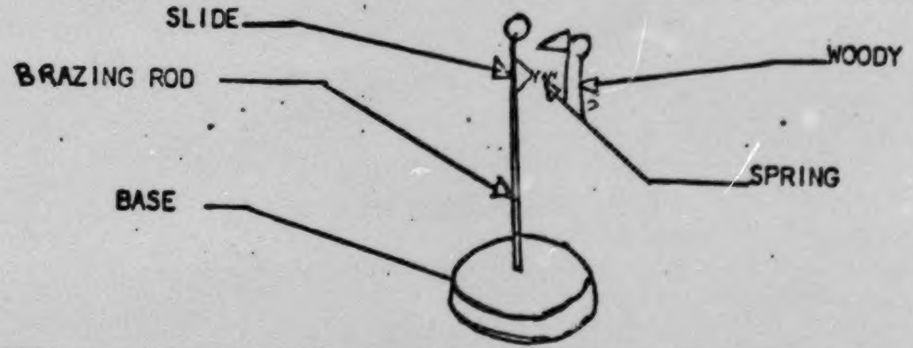
CERAMICS

POLYMERS ✓

FIBEROUS

COMPOSITES

DRAWING



TOOLS AND EQUIPMENT

- Rule
- Needlenose pliers
- Scroll Saw
- Drill press
- Sander
- File
- Sandpaper
- Band saw
- Glue
- 3/32" Brazing Rod
- 5/64" & 7/64" Drill bits

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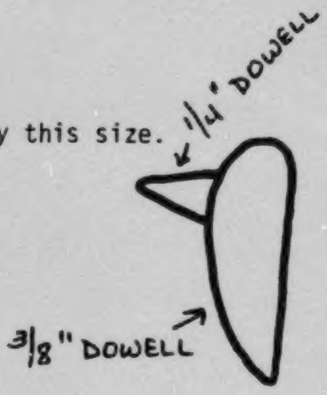
PROCEDURES

1. Select wood from short storage.
2. Choose shape for base.
3. Draw shape on wood.
4. Cut out on bandsaw or scroll saw.
5. Drill 5/64" hole 1/2" deep into base.
6. Cut 3/8" dia. circle (from 3/8" stock) for slide.
7. Drill 7/64" hole in center of slide.
8. Handwork woodpecker to desired shape. Approximately this size.
9. Sand all wood parts.
10. Finish woodpecker to desired color.
    (Danish oil, stain or paint.)
11. Finish base and slide with Danish oil.
12. Cut spring to 1/2" (spring from pen works good).
13. Glue spring to woodpecker and slide with white glue or duco cement.
14. Cut 15" of 3/32" brazing rod, and bend a loop in one end.
15. Slip slide over rod and insert rod into base.



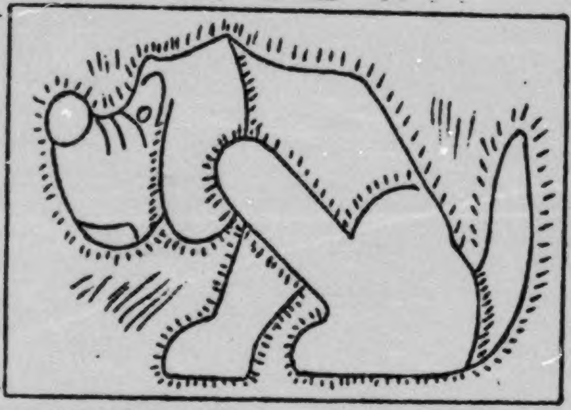
STUDENT PLAN SHEET

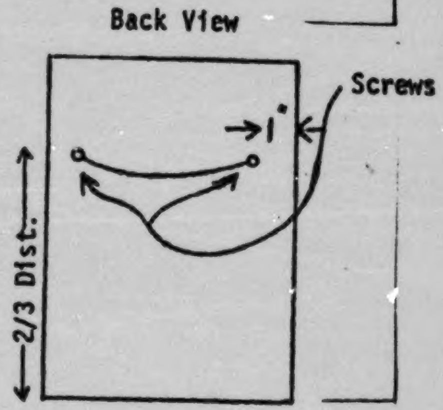
ACTIVITY TITLE Carved Wall Plaque
NAME
TOTAL COST
PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING





TOOLS AND EQUIPMENT

Carving Tools

Steel Scale

Screwdriver

Handsaw

Stain

Danish Oil

PROCEDURES

1. Draw or trace design on wood.
2. Cut ALL lines on the carving with a V tool.
3. Stop Cut all lines.
   A stop cut is made by cutting each line 1/16" to 1/8" deep.
4. Carve out against the stop cuts in the areas you desire.
5. The design should be carved about ½ the thickness of the wood.
6. After the stop cuts and other cuts are at the desired depth, round the placque to shape with carving tools.
7. Most carved projects should not be sanded. This removes the "Carved look."
8. Finish as desired. Stain or Oil look nice.
9. Mount screws and wire on back in order to hang your plaque.

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STUDENT PLAN SHEET

ACTIVITY TITLE Leather Barrette

NAME

TOTAL COST

PERIOD

CONTENT AREA

PROCESSES

FORMING

SEPARATING ✓

COMBINING

CONDITIONING ✓

FINISHING

MATERIALS

METALLIC

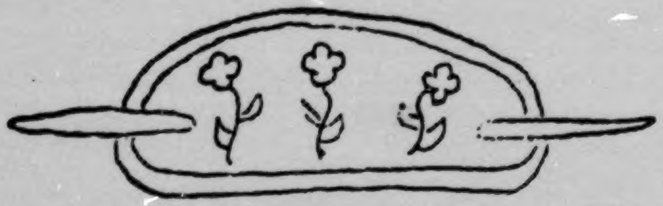
CERAMICS

POLYMERS ✓

FIBEROUS

COMPOSITES

DRAWING



MATERIAL

6-8 oz. leather

dowell(birch)

Tan Kote

Danish Oil

TOOLS AND EQUIPMENT

Scissors

Aviation snips

Leather stamping tools

Mallet

Wood (to cut on)

Marble block to stamp on

Brush

Revolving punch

Saw

Sandpaper

Swivel Knife

Pencil

PROCEDURES

1. Cut a piece of paper the exact size of the template for the leather barrette. Mark holes. Template is in crafts area.
2. Figure cost and record in your notebook on your expense record form.
3. Cut leather from edge of larger piece. Use aviation snips.
4. Dampen leather, lay paper pattern on leather and trace around it with leather stylus, Mark holes.
5. Stamp desired designs with stamping tools, cut stems where desired with swivel knife.
6. Punch holes with revolving punch.
7. Finish with omega dye (dyes are in finish area).
8. Finish with cova dye only if desired.
9. Bevel edges with edge beveler.
10. Dress edges with tan kote & smooth with edge slicker.
11. Rub tan kote in finish area. Wait until dye dries.
12. Cut dowel to length, finish ends and sand. (To point use pencil sharpener.)
13. Danish oil dowel.

STUDENT PLAN SHEET

ACTIVITY TITLE Cold Chisel

NAME

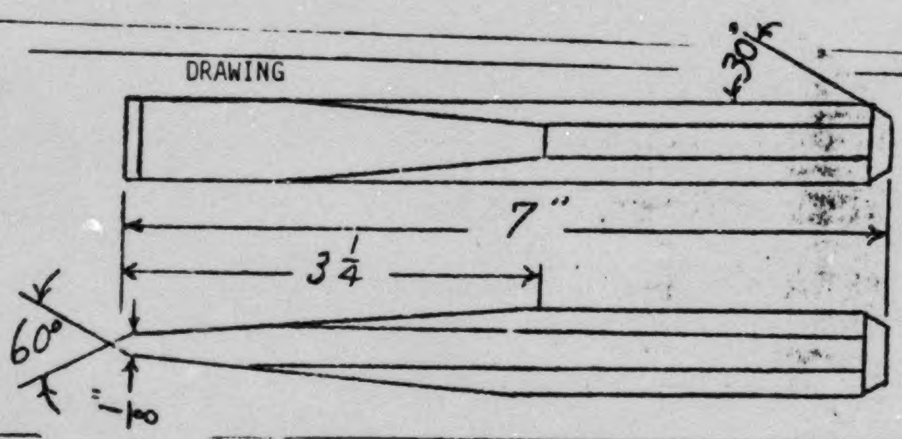
TOTAL COST

PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING	✓	FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

½" X 7" Octagon Tool Steel

Emery

Steel Wool

TOOLS AND EQUIPMENT

Forge

Anvil

Blacksmith Hammer

Tongs

Files

Grinder

Buffing Wheel

PROCEDURES

NOTE: MAKE USE OF THE CHISEL DISPLAY BOARD WHEN MAKING YOUR CHISEL.

1. Use a half round double-cut bastard file to cut off a fiece of ½" diam. meter octagon tool steel 7" long.
2. Heat octagon tool steel in forge to bright red and forge to a taper.
3. Continue to heat octagon tool steel to a bright red and forge taper until completed. Caution: When metal is no longer bright red in color, stop forging and reheat.
4. Anneal the piece of octagon tool steel by heating to a bright red and putting in sand to cool overnight.
5. Next day, use a double cut bastard file to remove forging marks.
6. Draw file the chisel with a single cut mill file.
7. Polish the chisel with a piece of coarse abrasive cloth, then a piece of fine abrasive cloth.
8. Harden and temper the cutting end.
9. Grind the head and cutting edge to shape as in drawing.
10. Test for hardness by cutting on a scrap piece of metal. Retemper if necessary.
11. Polish with a fine piece of abrasive cloth.
12. Polish on buffing wheel.

STUDENT PLAN SHEET

ACTIVITY TITLE Leather visor

NAME

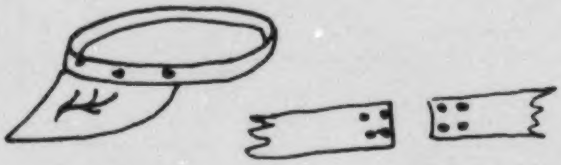
TOTAL COST

PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING		METALLIC	
SEPARATING	✓	CERAMICS	
COMBINING	✓	POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING		COMPOSITES	

DRAWING



MATERIAL

6-8 oz. Tooling leather

5 rivets Medium size

Lace, leather dyes

Antiquing , Tan Kote

TOOLS AND EQUIPMENT

Leather shear

Leather punch

Saddle stamps

Swivel Knife Optional

Edge Beveler

Edge slicker

PROCEDURES

1. Lay out template on leather (do not waste), draw pattern. (No ball point)
2. Cut out with leather shear.
3. Bevel edges.
4. Slick edges.
5. Punch rivet holes.
6. Case leather - use clean sponge, cloth or paper.
7. Carve design with swivel knife - this is an optional step.
8. Use appropriate saddle stamps.
9. Dye leather (it may be antiqued after dyeing).
10. Apply tan kote or other leather preservative.
11. Rivet visor to band.
12. Cut band in back to exact head size.
13. Punch 4 holes in the ends of each head band strap.
14. Lace ends and adjust to your size.

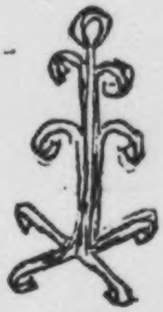
STUDENT PLAN SHEET

ACTIVITY TITLE Decorative Mug Tree
NAME ____________
TOTAL COST ____________
PERIOD ____________

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING		CERAMICS	
COMBINING	✓	POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING		COMPOSITES	

DRAWING



MATERIALS

T W L

2 1/8" X 1/2" X 11 Flat Bar
1 ¼" X 15 Round Stock
2 1/8" X 3/8" X 7 Flat Bar
2 1/8" X 3/8" X 14 Flat Bar
1 ¼ 20 Hex Nut

TOOLS AND EQUIPMENT

Hack Saw
File Diacro Metal Former
Drill
Tap and die
Silver solder
Torch
Forge
Hammer
Abrasive paper
Paint

PROCEDURES

1. Obtain stock and cut all pieces to length using hack saw.
2. Forge recess in bottom support.
3. Layout and drill hole through both supports (use correct drill side.)
4. Tap hole in tip cross support.
5. Thread round stock approximately ½ inch.
6. Using Diacro bender, form loops on support ends.
7. Form cup hangers on Diacro. Make each bend the same. Form top loop.
8. File and smooth all raw edges.
9. Assemble bottom supports with upright rod.
10. Silver solder cup hangers and top loop to rod and top support member.
11. Finish surfaces and prepare for paint.
12. Spray paint with primer and finish coat.

STUDENT PLAN SHEET

ACTIVITY TITLE Weiner fork

NAME

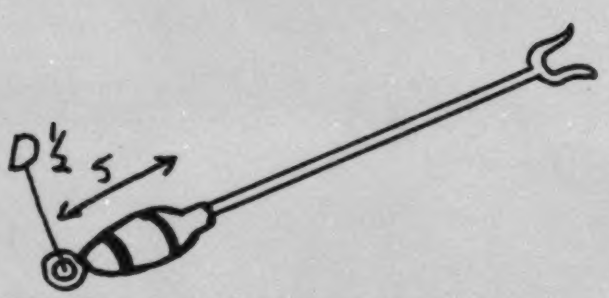
TOTAL COST .60

PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING		CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIALS

5/16 X 24 Round Mild Steel

Welding rod

4 X ½ X 5" round mild steel

TOOLS AND EQUIPMENT

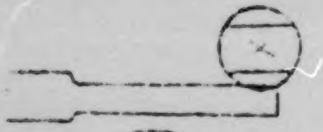
- Forge
- Anvil
- Blacksmith Hammer
- Hacksaw
- Gas Welding Equipment
- Awl
- Ruler
- Cold Chisel
- File

PROCEDURES

1. Cut 1 - 5/16" X 24" Long round mild steel rod.
2. Heat in forge until bright red. Place on anvil and forge two sides flat about 4" from the end.
3. Reheat in forge, place one round side on anvil and strike the other round side until they are flat. The four sides should form a square from the end.
4. Repeat steps 2 and 3 until you have made the round rod square. Make sure that the flat surface lays on the anvil when you start to square a new section.
5. Make sure that all surfaces are in a straight line and at right angles to each other.
6. Remember-do small sections at one time, making sure that they are square before starting another section.
7. Heat one end and flatten one end for a distance of 2" until 1/8" X 1/2" X 2" long.
8. Draw a center line in the center of the flattened area. Cut with a hacksaw.
9. Heat to a bright red, clamp in bench vise and spread open with a cold chisel.
10. Forge each section to a square taper.
11. Forge each square taper round.
12. Bend in a bending jig the two points into the desired shape.
13. Cut 4 ¼ X 5" pieces of round mild steel.
14. Wire the 4 pieces together and weld both ends for ½".
15. Heat to a cherry red and clamp one end in a bench vise, a wrench on the other end and twist tight, then turn wrench around and open up the twist to desired shape.
16. Make a ring by cold binding a piece of ¼ mild steel around a ½" round rod.
17. Gas weld the ring to the handle and the handle to the square rod.
18. Heat and wire brush the project.
19. Finish with desired finish.

Additional drawings on following page

2.



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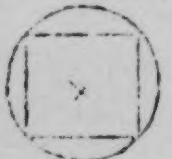

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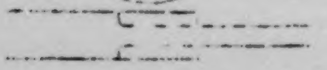

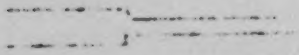

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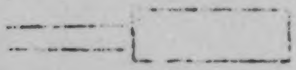

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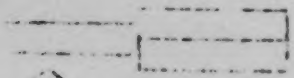

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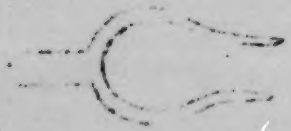


STUDENT PLAN SHEET

ACTIVITY TITLE Welded Candle Holder

NAME ______

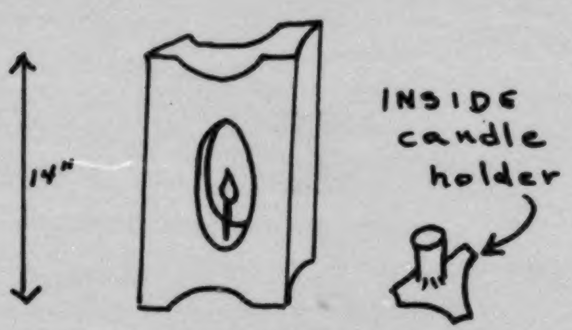
TOTAL COST .75

PERIOD ______

CONTENT AREA

PROCESSES		MATERIALS	
FORMING		METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

22 gauge black iron.

3 pcs. 6 X 14"

1 pc. 3/4" Pipe 1" long

TOOLS AND EQUIPMENT

Metal shear

forming roll

Oxy-acetylene welding set

Welding vise grips

Hack saw

PROCEDURES

1. Cut out stock--Metal shear
2. Trace pattern on all three pieces, with soap stone.
3. Shape side in forming roll.
(rear roller should be ¼" back of front roller)
4. Using #0 cutting tip, oxy - acetylene, cut the three pieces to shape. Save 1 piece of center cutout for later use.
5. Assemble two sides together, holding with welding vise-grips. Use 3 vise grips
6. Using #0 or #1 Welding tip, oxy-acetylene fusion weld, (weld without rod), 11 spots along the edge, equally spaced.
7. Release the three clamps.
8. Weld without rod along the entire edge, combining all spots that held the sides together.
9. Clamp the third side in place and spot it to one other edge.
10. Weld without rod along this edge.
11. Complete the third edge in the same manner.
12. Cut out piece which fits in bottom and holds conduit. (center cutout)
13. Cut 1" long pc. of 3/4" conduit and braze it to small shaped pc. of metal.
14. Fit this assembly into bottom of candle holder and braze into place.
15. To complete decoration of candle holder, melt brazing rod around all edges of assembly at approximately 1" intervals.

STUDENT PLAN SHEET

ACTIVITY TITLE Charcoal Tongs

NAME

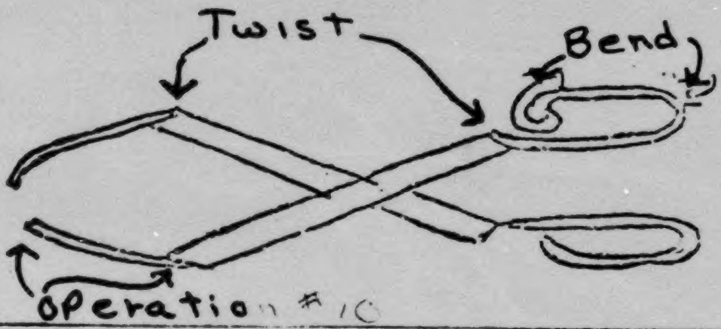
TOTAL COST .60

PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

2 pc. 1/8" X ½" X 24" mild steel

1 only 3/15" X ½" RH rivet

TOOLS AND EQUIPMENT

Hacksaw

Grinder

12" Adjustable wrench

Center punch

File

Ball Peen hammer

Scribe

Vise

3/16" twist drill

Drill Press

Rivet dolly

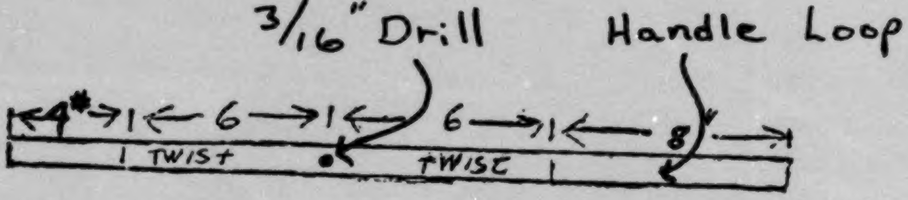
Rivet set

Bending jig

Steel Scale

PROCEDURES

1. Cut mild steel to length with hacksaw.
2. Dress corners on grinder
3. Layout with scribe and center punch reference points.
4. Twist metal in vise. Place metal in vise to the mark. Hold wrench 3/4" from mark.
5. Drill 3/16" diameter pivot holes. Drill press
6. Remove burr of holes with file.
7. Bend handles on 1½" pipe to form loops. Bend #1 right angle around ½" rod. Bend #2 around 1½" rod to point of twist.
8. Squeeze handle in vise to close opening.
9. Match handles and assemble with rivet.
10. Bend 4" end to match drawing
11. Adjust jaws for alignment with each other.
12. Spray with flat black paint.



STUDENT PLAN SHEET

ACTIVITY TITLE Formed Tray

NAME

TOTAL COST 1.00

PERIOD

CONTENT AREA

PROCESSES

FORMING ✓

SEPARATING ✓

COMBINING

CONDITIONING

FINISHING ✓

MATERIALS

METALLIC ✓

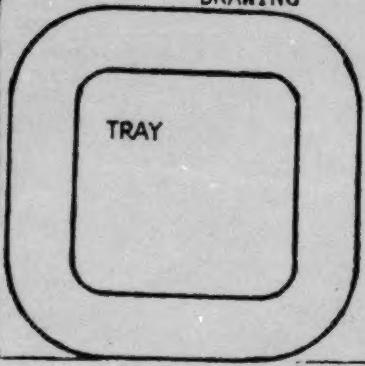
CERAMICS

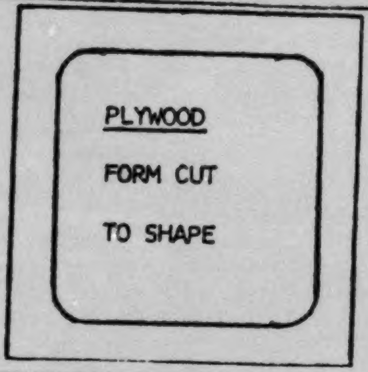
POLYMERS ✓

FIBEROUS

COMPOSITES

DRAWING





MATERIAL

3/4" X 12 X 12 plywood

20-24 Ga. 12 X 12 Aluminum

4 Nails

Steel Wool fine

Abrasive cloth fine

TOOLS AND EQUIPMENT

Forming hammer

Tin snips

Single cut file

Ball peen hammer

Band saw

Jig saw

Drill press

Saber saw

Buffer

PROCEDURES

1. Draw the shape that you want your tray, eg. round, oval, irregular.
2. Draw the tray shape on the center of the 12 x 12 piece of plywood.
3. Cut the tray shape out of the center of a 3/4" piece of plywood with a bandsaw.
4. Cut a piece of 24 gauge aluminum 12" x 12" and draw the layout line showing the section to be beaten down.
5. Nail the metal at the corners to the form, to hold in place over the form.
6. Use a metal or wood face forming hammer. Strike the metal with glancing blows inside the layout line area to be sunk.
7. As the metal takes shape, work towards the center in rows until the metal is stretched to the bottom of the form.
8. As you work the metal it will become hard, the metal will require annealing.
9. Planishing smoothes away hammer marks and will give a fine finish to the metal surface.
10. Finish the project by cutting, filing, and enriching the edge as desired.
11. Clean with fine steel wool.
12. Buff to the desired luster.

STUDENT PLAN SHEET

ACTIVITY TITLE Fireplace Tool Holder
NAME ______
TOTAL COST ______
PERIOD ______

CONTENT AREA

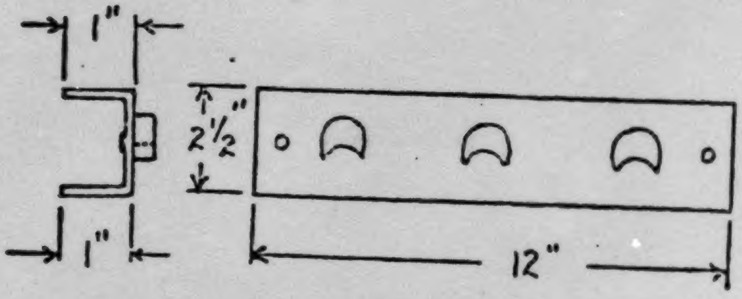
PROCESSES

FORMING ______
SEPARATING ✓
COMBINING ✓
CONDITIONING ______
FINISHING ✓

MATERIALS

METALLIC ✓
CERAMICS ______
POLYMERS ______
FIBEROUS ______
COMPOSITES ______

DRAWING



MATERIAL

1 PC. 16 or 18 ga. sheet metal

1 pc. Walnut 1 ½" X 5 X 3/4"

6 ½ X 6 Panhead sheet screws

TOOLS AND EQUIPMENT

- Bandsaw
- Drill press
- Disc sander
- metal shear
- Box and pan brake
- Electric hand drill ¼, 1/8, 3/32" twist drills
- File
- Screwdriver
- Sandpaper

PROCEDURES

1. Using the hanger part of the handles of your previously constructed fireplace tools as a template, draw hanger block designs on walnut.
2. Cut out on bandsaw.
3. Sand convex surface on disc sander.
4. Sand concave surface using 11/16" drum sander on drill press.
5. Hand sand until smooth. Chamfer face surface 1/16".
6. Apply Danish oil finish.
7. Cut 1 piece of 18 ga. sheet steel 4-1/2" x 12" using metal shear.
8. Remove sharp edges with file.
9. Using the template, mark and center punch hole positions.
10. Drill holes using drill press and proper drill sizes.
11. Lay out bend lines 1" from edge on the long side of sheet steel.
12. Bend to 90° on box & pan brake.

STUDENT PLAN SHEET

ACTIVITY TITLE Bench Metal Fireplace Brush

NAME ____________________

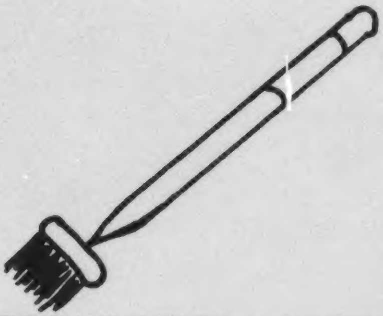
TOTAL COST ____________________

PERIOD ____________________

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING	✓	POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

1 Brush blank

1 pc. 1/8 X ½ X 52" flatbar

1 pc. 1 X 1½ X 11" hardwood

6 #6 X 3/4 pan head sheet metal

1 1/8 X 3/8 iron rivet

TOOLS AND EQUIPMENT

Hacksaw

Rule

Drill press

Bending jig

Ball peen hammer

5/32 and 3/32 drills

Bandsaw

Sander

Center punch

Screwdriver

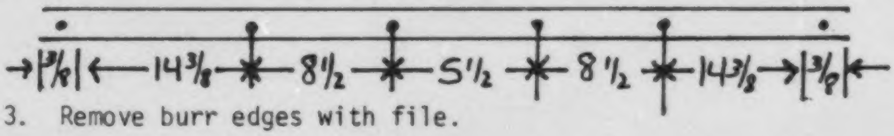
File

Drill press

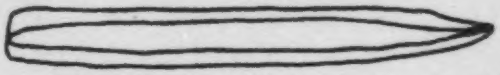
Vise

PROCEDURES

1. Cut flatbar with hacksaw.
2. Mark, center punch, and drill as shown in fig. 1. Drill all holes 5/32".



3. Remove burr edges with file.
4. Find center and bend over 1-1/2" pipe.



5. Mark and bend out to right angles 1-1/2" from each ind as on shop model.
6. Mark with center punch 1" from brush end, clamp in drill press vise and drill 1/8" hole through both sides for 1/8" rivet on drill press.
7. Rivet two side together as on shop model.
8. Center handle on brush, mark, then drill 3/32" pilot hole 1/2" deep.
9. Fasten brush to handle with 2 no. 6 pan head sheet metal screws.
10. Spray all but bristle part of brush with flat black paint.
11. Select, layout with template, and cut wood on bandsaw for handle inserts.
12. Sand smooth and finish with oil finish.
13. When finishes are dry, place wood insert in handle, drill 3/32" pilot holes and fasten in place with 4 pan head sheet metal screws as shown on shop model.

STUDENT PLAN SHEET

ACTIVITY TITLE Bench Metal Fireplace Poker

NAME ____________________

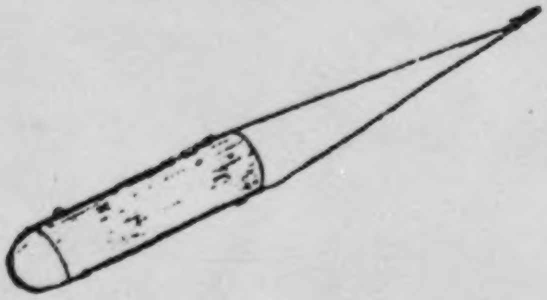
TOTAL COST ____________________

PERIOD ____________________

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	✓
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIALS

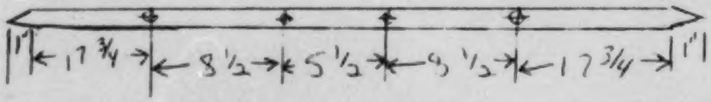
- 1 pc. 1/8 X ½ X 60 flatbar
- 1 pc. 1 X 1½ X 11 hardwood
- 4 #6 pan head S,M, screws
- 1 1/8 X 3/8 iron rivet

TOOLS AND EQUIPMENT

- Hacksaw
- Rule
- Drill press
- Bending jig
- Ballpeen hammer
- Center punch
- File
- Adjustable wrench
- Screwdriver
- 5/32 & 3/32 drills

PROCEDURES

1. Cut 60" pc. of 1/8 X ½ flatbar.
2. Layout, center punch, and drill 5/32" holes as shown in fig. 1, using drill press.



3. Layout and taper ends as shown in fig. 1 with hacksaw or file. remove drilling burr with file.
4. Place in bending jig and bend as shown in fig. 2.

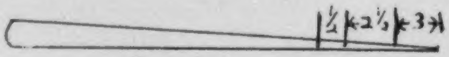


Fig 2

5. Place in vise at point A (shown in fig. 2, place 12" adjustable wrench at point B, leaving 2½" between vise and face of wrench. Turn wrench 3/4 revolution.
6. Move up in vise, center punch, and drill with 1/8 drill, install 1/8" soft iron rivet.
7. Place in vise and bend point of poker.
8. Spray with black paint.
9. Select, layout with template and cut wood for handle insert.
10. Sand smooth and finish with oil.
11. When finishes are dry, place wood insert in handle, drill 1/8" pilot holes and fasten in place with 4 pan head sheet metal screws.

STUDENT PLAN SHEET

ACTIVITY TITLE Bench Metal Fireplace Shovel

NAME ______

TOTAL COST ______

PERIOD ______

CONTENT AREA

PROCESSES

FORMING ✓

SEPARATING ✓

COMBINING ______

CONDITIONING ______

FINISHING ✓

MATERIALS

METALLIC ✓

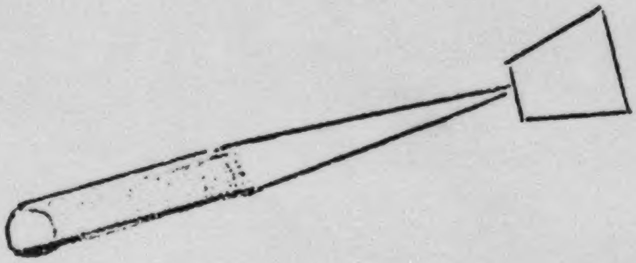
CERAMICS ______

POLYMERS ✓

FIBEROUS ______

COMPOSITES ______

DRAWING



MATERIAL

1 PC. 1/8 X ½ X 52 flatbar

1 pc. 1 X 1½ X 11 hardwood

1 pc. 5½ X 6½ 20 ga.black iron

4 # 6 3/4" pan head self tapping screws

5 1/8 X 3/8 iron rivets

TOOLS AND EQUIPMENT

Hacksaw

Rule

Drill

Bending jig

Ball peen hammer

Center punch

Rivet set

File

Tin snips

Pan brake

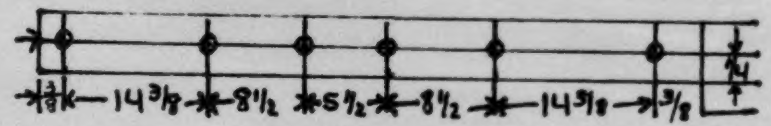
Drill press

vise

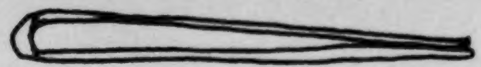
band saw

PROCEDURES

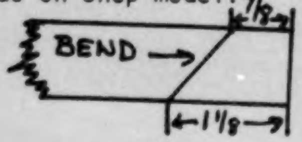
1. Cut 52" piece of 1/8 x 1/2 flatbar.
2. Mark, center punch, and drill as shown in fig. 1. Drill two end holes 1/8", the rest 5/32.



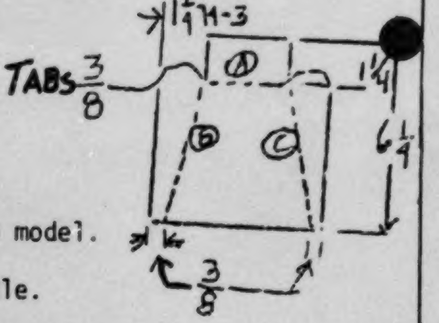
3. Remove burr edges with file.
4. Find center and bend over 1-1/2" pipe.



5. Layout ends as show in fig. 3. Place in vise and bend as on shop model.



6. Drill and rivet two ends together as on shop model.
7. Layout black iron for shovel as shown in fig. 4.
8. Cut out with tin snips.
9. Bend on pan brake as on shop model.
10. Drill and rivet back of shovel as on shop model.
11. Drill and rivet handle to back of shovel as on shop model.
12. Select, layout with template, and cut wood for handle.
13. Sand smooth and finish with oil.
14. Place wood insert on handle, mark, drill 3/32 pilot holes. and fasten with 4 pan head screws as on model.



STUDENT PLAN SHEET

ACTIVITY TITLE Brass Hammer

NAME

TOTAL COST

PERIOD

CONTENT AREA

PROCESSES

FORMING

SEPARATING ✓

COMBINING

CONDITIONING

FINISHING ✓

MATERIALS

METALLIC ✓

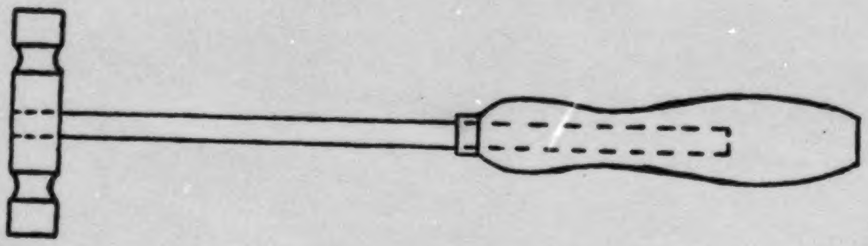
CERAMICS

POLYMERS

FIBEROUS

COMPOSITES

DRAWING



MATERIAL

½ X 2½" round brass

¼ X 6" steel rod

small file

handle

TOOLS AND EQUIPMENT

Metal lathe

Rule

Files

Emery cloth

¼, 7/32 and #7 drills

¼" 20 tap and die

Vise

Drill press

hacksaw

Center punch

hammer

File card

PROCEDURES

1. Tighten in lathe chuck.
2. Face end.
3. Chamfer end with tool file.
4. Measure, mark and cut or file groove.
5. File lightly and polish with emery cloth.
6. Reverse in chuck and repeat steps 1 to 5.
7. Measure, mark and center punch at middle.
8. Drill with a #7 drill.
9. Thread with a 1/4" - 20 tap.

HANDLE:

1. Cut 1/4" x 7" round steel rod.
2. Round ends and thread 1/4" - 20 for 1/2" on one end and 1-1/2" on other end.
3. Drill file handle with 7/32" and 1/4" drills.
4. Assemble and file steel rod round at head.
5. Paint handle.

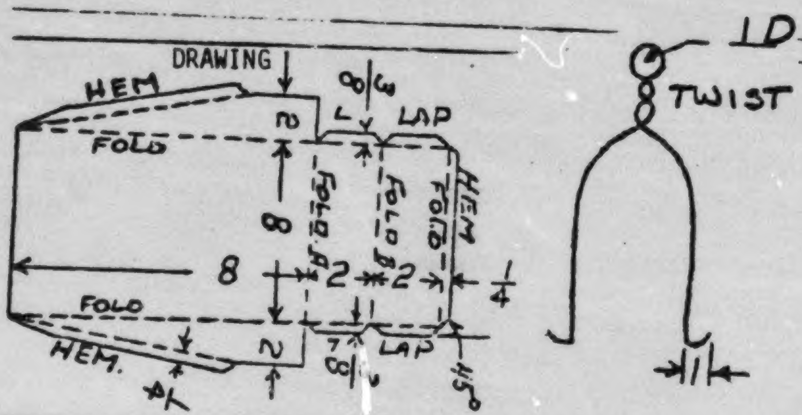
STUDENT PLAN SHEET

ACTIVITY TITLE Dust Pan
NAME
TOTAL COST
PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING


1D
HEM
FOLD
3/8
LAP
2
8
FOLD
FOLD
FOLD
HEM
8
2
2
1/4
FOLD
HEM.
2
3/8
LAP
45°
TWIST
1

Material

28 ga. Galvanizing

Sheet Metal Rivets

40" 3/16 Round mild steel

TOOLS AND EQUIPMENT

Marking gauge

Tin ships

Rivet set

Rivet punch

Ball peen hammer

Combination square

.Awl

Single cut file

Brake

233

PROCEDURES

1. Make a full size drawing of the dust pan.
2. Cut 1 piece of 26 gauge galvanized sheet metal 12-1/2" x 12-1/4" long.
3. Use an awl and combination square to lay out all lines on the piece of sheet metal. Follow the drawing for layout.
4. Check to make sure you have made all lines before cutting out with the tinner snips.
5. Use a single cut file to file all cutting edges.
6. Use the brake to fold and set all hems.
7. Use the brake to fold the (2) sides and (4) lap joints at 90^0 bend.
8. Use your handle to fold the back and top.
9. Square off the bend with a mallet and a block of wood.
10. Mark and punch rivet holes with a rivet punch.
11. To set the rivets use a rivet punch and a ball peen hammer.
12. Cut 1 piece of 3/16" x 40" long round mild steel rod.
13. Bend in half around a 1" dia. pipe, and twist 3 times.
14. Bend the ends at a 60^0 angle for 1".
15. Assemble the handle to the dust pan.
16. Finish with desired finish.

STUDENT PLAN SHEET

ACTIVITY TITLE Engraved Wrist Band

NAME ____________

TOTAL COST ____________

PERIOD ____________

CONTENT AREA

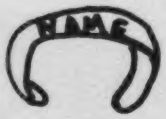
PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING		CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING		COMPOSITES	

DRAWING

MATERIAL

.040 Thick X 1" Wide X 6" long X

.040 Thick Aluminum band T6 Hard



Aluminum

TOOLS AND EQUIPMENT

Vibro engraver

Single cut file

Buffing machine

Squareing shear

Tin snips

foot rule

Tape

1¼" round pipe or bar

PROCEDURES

1. Cut material 1 inch x 6 inches with tin snips or squaring shears.
2. Cut and file band to desired shape.
3. Lay out design or name on a 1" x 6" piece of paper.
4. Polish all surfaces of aluminum wrist band blank on buffer.
5. Place paper pattern over metal blank and tape in place.
6. Engrave name and design on metal with vibro engraver.
7. Bend to fit wrist by hand and by laying it over a round pipe or bar and tapping with rawhide mallet.

STUDENT PLAN SHEET

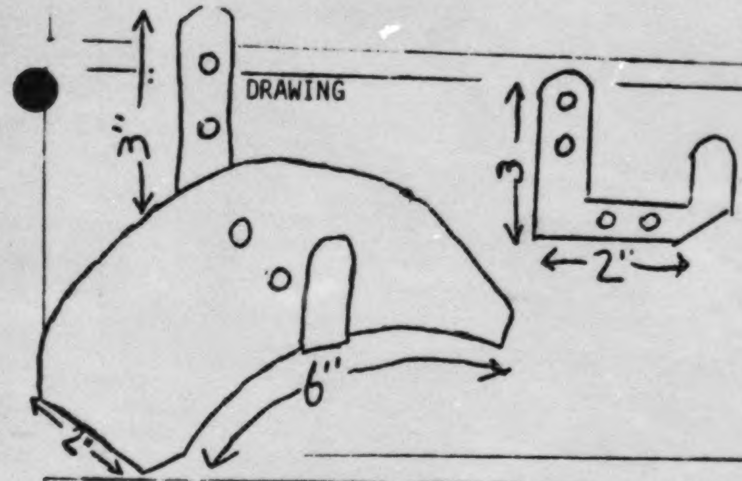
ACTIVITY TITLE Cord Holder NAME ____

TOTAL COST ____ PERIOD ____

CONTENT AREA

PROCESSES		MATERIALS	
FORMING	✓	METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING		FIBEROUS	
FINISHING	✓	COMPOSITES	

DRAWING



MATERIAL

1 pc. sheet metal 2 X 6"

1 pc. flat bar 1/8" X ½" X 6"

2 rivets R.H.S. 1/8" X 3/8"

TOOLS AND EQUIPMENT

Hacksaw	Squaring shear
Drill press	Tin snips
Grinder	Forming roll
Steel scale	Electric Drill
Vise	Rile
Ball peen hammer	Rivet set
Abrasive cloth	1/16" twist drill

PROCEDURES

1. Cut 1 piece of 1/8" flat scroll bar 6" long using hacksaw.
2. Round off ends on grinder or with a file.
3. Center punch 2 rivet holes and 2 mounting holes.
4. Drill four 1/8" holes , drill press or electric drill.
5. Shape flat bar as shown in sketch.
6. Cut 1 piece of sheet metal 2" x 6".
7. Cut 1/4" diagonally across each corner.
8. File edges to remove burr.
9. Roll to desired shape in forming roll.
10. Clamp sheet metal to flat bar and drill rivet holes through sheet metal.
11. Rivet sheet metal to flat bar.
12. Sand all edges to relieve sharpness.
13. Paint with desired color.

STUDENT PLAN SHEET

ACTIVITY TITLE Nail Set

NAME

TOTAL COST

PERIOD

CONTENT AREA

PROCESSES

FORMING

SEPARATING ✓

COMBINING

CONDITIONING ✓

FINISHING

MATERIALS

METALLIC ✓

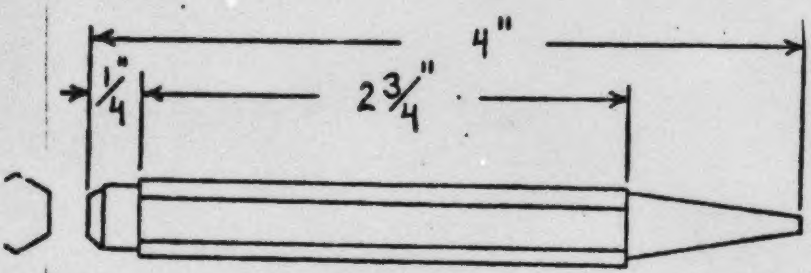
CERAMICS

POLYMERS

FIBEROUS

COMPOSITES

DRAWING



MATERIALS

5/16" X 4" hexagonal tool steel

TOOLS AND EQUIPMENT

Metal lathe

Tool bit and holder

Rule

Files

Emery cloth

Bench Furnace

File card

PROCEDURES

1. Obtain 5/16" tool steel.
2. Tighten in lathe chuck.
3. Face end.
4. Straight turn end for 1/4"
5. File smooth, chamfer edge and polish.
6. Reverse stock in chuck.
7. Face end.
8. Concave end. Use round nose tool, or a drill.
9. Set compound rest at 5° and turn the taper.
10. File smooth, chamfer the edge and polish.
11. Harden and temper.
12. Repolish.

NOTE: Nail sets may be made in a variety of sizes.

245

STUDENT PLAN SHEET

ACTIVITY TITLE Prick Punch

NAME

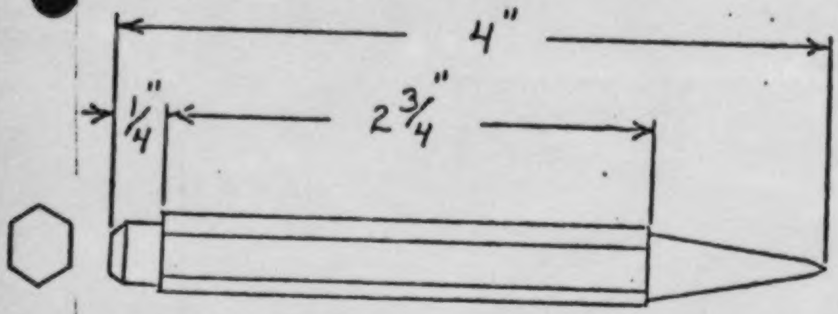
TOTAL COST

PERIOD

CONTENT AREA

PROCESSES		MATERIALS	
FORMING		METALLIC	✓
SEPARATING	✓	CERAMICS	
COMBINING		POLYMERS	
CONDITIONING	✓	FIBEROUS	
FINISHING		COMPOSITES	

DRAWING



MATERIAL

5/16" X 4" Hex tool set

TOOLS AND EQUIPMENT

Metal lathe

Rule

Files

Emery cloth

Bench furnace

File card

PROCEDURES

1. Obtain 5/16" tool steel.
2. Tighten in lathe chuck.
3. Face end.
4. Straight turn head end for 1/4".
5. File smooth, chamfer edge and polish.
6. Reverse stock in chuck.
7. Set compound rest at 5° and hand feed to cut the taper.
8. Set compound rest at 15° and cut the point.
9. File smooth and polish.
10. Harden and temper to a purple color.
11. Re-polish.

STUDENT PLAN SHEET

ACTIVITY TITLE Metal Spinning

NAME ____________

TOTAL COST .20

PERIOD ____________

CONTENT AREA

PROCESSES

FORMING ✓

SEPARATING ____________

COMBINING ____________

CONDITIONING ____________

FINISHING ✓

MATERIALS

METALLIC ✓

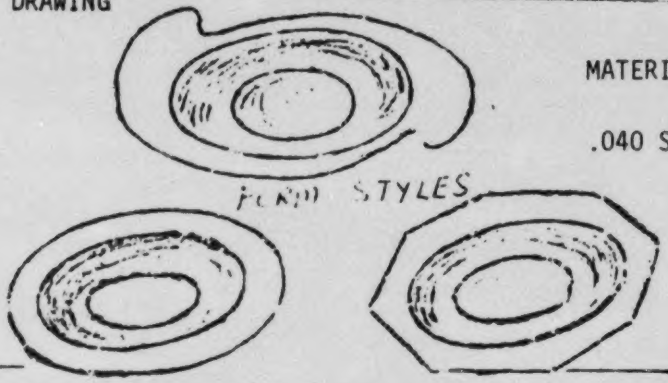
CERAMICS ____________

POLYMERS ____________

FIBEROUS ____________

COMPOSITES ____________

DRAWING



MATERIALS

.040 Soft aluminum

TOOLS AND EQUIRMENT

- Lathe
- Spinning Jib
- Spinning Rest
- Dowel stick
- Bar paraffin or soap
- Tin snips
- Drill press
- Center punch
- 8" Crescent wrench
- Squaring shear
- Paraffin
- File
- Buffer
- 3/8" twist drill

PROCEDURES

1. Select metal.
2. Cut metal square to fit spinning jig with tin snips. Cut from edge of sheet 7-3/4" square. Could also be cut with squaring shear, set back gauge at 7-3/4".
3. Place square metal blank under metal drilling template and mark for drilling using center punch. Follow directions on the template.
4. Drill holes marked, with 3/8" twist drill. Clamp material before drilling to drill press.
5. Bolt metal to the wood jig.
6. Set up wood lathe for spinning.
7. Mount jig on lathe, same as for faceplate turning.
8. Turn on lathe to lowest speed.
9. Press paraffin to metal to be spun, coating surface.
10. Spin metal into wood jig with wood dowell stick. Use special spinning post in tool rest holder.
11. Remove spun metal from spinning jig.
12. Choose border style and cut out shape with tin snips.
13. File edge.
14. Buff edge on buffer using yellow buffing compound.

The Following Section Describes
and Identifies various Sources
of Curriculum Information and
Course Project Ideas.

A Suggested Planned Course in Industrial Arts - Grades 7 and 8

Summary: The course is designed to acquaint the student with environmental, consumer and occupational knowledge in a variety of industrial areas. Correlation of mathematics, science, social studies, fine arts, and language arts is a primary goal of the course.

For information contact:

Pennsylvania Department of Education
Box 911
Harrisburg, PA 17126

Materials and Processes Guide

A cooperative curriculum effort in the area of materials and processes. Funded by: Kansas State Department of Education

Preface:

Materials and Processes, a study of how man alters materials to increase their value, is a one year course designed for inclusion into the high school industrial education curriculum. Provision is made within the course for symbolic, vicarious, and direct purposeful learning experiences and the content is formulated to have appeal for girls and boys regardless of their educational and career goals.

See Activity area for examples of learning activites.

Wood Technology, Technique, Processes and Products

Summary: "New and Used Ideas" for your industrial arts woodworking classes and for wood product development in industry. The seven areas of wood technology, previewed in this bulletin, illustrate applicable techniques, processes, and products.

There is a companion slide-tape presentation For additional information on the guide and the slide series, write to:

Wood Technology
Industrial Ed Department
Southwest Missouri State College
Springfield, Missouri 65802

OCCUPATIONAL VERSATILITY (OV)

This is a Title III Project designed presently for middle or junior high school. The main objective is that the student will have the opportunity to determine and develop their own identity in a shop environment, to be self-sufficient, productive and adaptable.

Materials to assist a teacher in designing a facility, developing activities, formulating an accountability system, and a series of power equipment information sheets.

The O.V. users guide is available for $13.50 from:

Project Occupational Versatility
Albany Union School Dist. 8J
2010 South Elm
Albany, OR 97321

PARKES ADVENTUROUS PROJECTS

This program combines a mass production activity with a variety of individual, self-paced activities. Parkes philosophy is, "A Different Activity Every Day." Many of the Material and Processes activities are innovative, i.e. hydraforming, explosion forming, sandblasting, concrete forming, and others.

Parke is attempting to market his program and discourages single copy sales of the lab manuals. Minimum first order is 15 copies at $20.00/copy.

The special tooling is available from Parke at a relatively low price. He provides complete material lists and sources for supplies. For addition information write:

Parke's Adventurous Projects
Nelson L. Parke
805 South Devonshire
Springfield, MO 65802

Articulated Instructional Development (AID) booklets

AID booklets, developed in Alberta, are designed to assist students with the attainment of a meaningful experience related to the world of work. A check point system is used to provide for student safety, ensure a high quality of workmanship, and regulate efficient lab organizaition and utilization. Procedure, quality control, power equipment, and evaluation check points are used.

AID booklets are 8½ X 5½. Almost every page has a picture to illustrate the procedure for that page. Sentences are few and short.

A copy of each of the 129 booklets is available by writing:

Dr. A. E. Morris
c/o Education Centre Building
515 Macleod Trail Southeast
Calgary, Alberta
T2G 2L9

'73 Package

The A.I.D. Project (1973) contained the following 80 titles:

AID PACKAGE (1973) TITLES

MATERIAL TECHNOLOGIES

Metals

Tin Box
Cookie Cutter
Scoop
Letter Holder
Candle Holder
Bottle Opener
Key Tag
Screwdriver
Tack Hammer - Handle
Tack Hammer - Head & Shaft
Die

Woods

Pot Stand
Book Ends
Tick-Tack-Toe
Cutting Board
Book Ends
Noise Maker
Mint Bowl
Coat Hanger

Plastics

Soap Tray
Pen Base
Coin Purse
Insulated Jar
Screwdriver (SPI)
Football (Cantech)
Coasters (Cantech)
Coasters (Advance)
Candle Holders
Pin Tray
Salad Servers
Recipe Holder

Other Materials

Foot Scraper
Stepping Stone
Goblet
Glass Mug
Hot Pot Stand
Book Marker
Comb Case
Embossed Key Case
Tooled Key Case

GRAPHIC/POWER TECHNOLOGIES

Graphics

Overview of Drafting
Sketching and Shading
Drawing Techniques
Drafting Exercises
Taking A Picture
35mm Negative
Contact Print
Enlarged Print
Story Board
Portrait
I.D. Card
Photo Album
Poster
Auto Record Book
Note Book Dividers
Name and Address
Autograph Book
Tee Shirt Printing
Principle of Offset Lithography
Homework Diary
Memo Pad (AM)
Memo Pad (AB Dick)
Personalized Stationery
Personalized Stationery
Personalized Memo Pad

Power

Kohler Engine - Disassembly
Kohler Engine - Assembly
Kohler Engine - Running
Electrical Power Sources #1
Electrical Power Sources #2
Hydraulic Jack
Air Hammer
Air Motor
Balance - Block and Tackle
Transistor Radio
Pendulum Generator
Lighting Circuits
Alarm Systems
Belt and Chain Transmission
Gear Transmission

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Yearbook (1974)

As a result of the A.I.D. Project (1973) monies were generated in the name of the Instructional Media Committee. These monies were used to pay honorarium to the authors and the publication costs of the A.I.D. Yearbook (1974). The sale of the A.I.D. Yearbook (1974) again replenished the account of the I.M.C. so that a 1976 Yearbook was possible. The chain reaction has now been started, it will be up to the industrial education teachers in the field to keep it going.

'74 Authors

1974 YEARBOOK TITLES AND AUTHORS

MATERIAL TECHNOLOGIES

SKATE TIGHTENER	13	METALS-E04	R. Radons, V. Yuschyshyn
COLD CHISEL	13	METALS-E05	A. Garrett, R. Baker
GARDEN/CORD HOLDER	13	METALS-E06	A. Garrett, R. Baker
FISH LINE WEIGHTS	12	METALS-B01	A. Garrett, R. Baker
MAIL SORTER	25	WOODS-A07	A. Garrett, R. Baker
BOOT JACK	13	WOODS-A08	R. Radons, V. Yuschyshyn
WINDSHIELD SCRAPER	11	PLASTICS-G05	L. Robinson
RING	12	PLASTICS-[illegible]01	H. Langdon
SWIZZLE STICKS	12	EARTHS-E03	A. Garrett, R. Baker
INDUSTRIAL SIMULATION	T	INDUSTRIAL SIMULATION-A01	A. Garrett, R. Baker
INDUSTRIAL SIMULATION	T	INDUSTRIAL SIMULATION-B01	A. Garrett, R. Baker

GRAPHICS/POWER TECHNOLOGIES

ORTHOGRAPHIC DRAWING	13	GRAPHICS-A05	A. Klammer, J. Matechuk
ISOMETRIC DRAWING	13	GRAPHICS-A06	A. Klammer, J. Matechuk
FLASH UNIT OPERATION	12	GRAPHICS-B09	J. Matechuk
STEAM ENGINE	12	POWER-A07	A. Garrett, R. Baker
SOLID STATE CIRCUITS	13	POWER-B04	D. Broadhead
CIRCUIT TESTER	13	POWER-C06	R. Parker
CO2 RACING CAR - BUILDING	13	POWER-C07	V. Yuschyshyn
CO2 RACING CAR - TESTING	13	POWER-C08	V. Yuschyshyn
ELECTROMAGNET/SOLENOID	13	POWER-C09	D. Broadhead

Yearbook
(1976)

Fourteen authors kept the Yearbook concept moving with the writing of twenty-nine new A.I.D. titles.

1976 YEARBOOK TITLES AND AUTHORS

'76 Authors

MATERIAL TECHNOLOGIES

SPICE RACK	12 METALS-A04	John Matechuk
GARDEN TROWEL	13 METALS-B07	Glen Sollid
PIN PUNCH	13 METALS-C04	Glen Sollid
HAMMER RACK	13 WOODS-A09	John Matechuk
TENNIS RACK	13 WOODS-A10	Glen Sollid
CASSETTE HOLDER	13 WOODS-A11	Glen Sollid
TOOL BOX	12 WOODS-A12	Glen Sollid
SKI HOLDER	13 WOODS-A13	Glen Sollid
SLINKY LAMA	13 WOODS-A14	Peter Hauca
SALT/PEPPER	13 WOODS-B02	John Matechuk
HOT POT STAND	13 WOODS-C02	John Matechuk
DESK NAME PLATE	12 PLASTICS-G06	Les Kettles
TOOTHBRUSH HOLDER	12 PLASTICS-G07	Les Kettles
PICTURE HOLDER	12 PLASTICS-G08	John Matechuk
KEY HOLDER	13 PLASTICS-H02	Bob Parker

GRAPHICS/POWER TECHNOLOGIES

OBLIQUE DRAWING	13 GRAPHICS-A07	John Matechuk/ Alex Klammer
LINE COPY NEG. ENL.	12 GRAPHICS-B10	Steve Wilson-Evans
DEV. PANATOMIC FILM	11 GRAPHICS-B11	John Krywko
PREP. PERSONALIZED MEMO	13 GRAPHICS-B12	Barry Kent
PREP. OF A FLAT	13 GRAPHICS-B13	Don Soldan
PLATE EXPOSURE DEV.	13 GRAPHICS-B14	Don Soldan
PRIN. OF COMPOSITION	13 GRAPHICS-B15	Rick Mageau
PREP. PERSONALIZED LETTERHEADS	13 GRAPHICS-B16	Barry Kent
PREP. PERSONALIZED POSTERS	13 GRAPHICS-B17	Barry Kent
PREP. PERS. BUSINESS CARD	13 GRAPHICS-B18	Barry Kent
PREP. PERS. ADVERTISEMENTS	13 GRAPHICS-B19	Barry Kent
PREP. STEN. SUPER PREP FILM	13 GRAPHICS-E03	John Matechuk
HAND OFFSET LITHOGRAPHY	13 GRAPHICS-F06	Dave Tidsbury
MODEL ROCKET	13 POWER-A08	Vic Yuschyshyn/ Rob Baker

The following attachments describe Shawano Industrial Education Demonstration Curriculum Project. For information contact:

Shawano IECP Project
Ainsworth Processing Center
Franklin Jr. High School
Shawano, Wisconsin 54166

SHAWANO INDUSTRIAL EDUCATION
DEMONSTRATION CURRICULUM PROJECT

Materials & Processes at Shawano is designed to teach students to become problem-solvers as well as equipment operators. By learning to do specific processes, and then applying this knowledge to learning activities or projects, students gain an understanding of a broad cluster of skills and also gain the ability to work with machines. Projects, which are satisfying accomplishments in their own right, are used to help develop an attitude toward understanding a whole cluster of related concepts and skills.

How does this happen? A student selects either Processes I or Processes II. Both are year-long courses, and the division into I and II is purely because of a facility limitation. Shawano would prefer to have only one, unified course. Processes I is taught in the metals shop, and II is taught in the woodshop.

Both courses begin with the teacher explaining the class objectives. Students are told that they will be learning how to be problem-solvers, as well as learning how to run machines and make things. After this introduction, instruction is given in four units:

I. Introduction to Structure & Definitions
II. Overview of Processes
III. Machine Analysis
IV. Measurement

(Plans for each of the four Units are found in following pages of this introduction.)

In the Introduction to Structure & Definitions Unit, students are taught the meaning of the term, Processes: The systematic series of actions involved in the transformation of materials in the production of goods. They learn about specific types of processes and are able to give their own examples of them.

The Cluster Model is explained. (See next page for a copy of the Model). For example, the terms on the Model which would be explained and taught are: extracted, grown, and manufactured; separating, growing, extracting, internal modification, finishing, combining, and forming. (Definitions of these terms are given in the plan for this unit in the following pages of this notebook.)

When students have a general idea of the concept of Processing, and an understanding of the topics included in the Cluster, the second unit is introduced: Overview of Processes. The first examples are given of the actual technical areas in which these processes are carried out. For instance, separating is discussed in terms of the functions of a lathe, a milling machine, and a curcular saw.

Unit III is Machine Analysis. Students learn the common characteristics of all machines before they start learning how to operate them. Power input, power transmission, and power output are the three broad descriptors used to talk about all machines. This basic, general understanding of machines will also be useful when students are confronted with learning how to run new machines in the future - perhaps even those machines which have not yet been invented.

In the Measurement Unit, linear and angular measurement are taught in terms of the different types of measuring systems. Tolerances and allowances are talked about, as well as direct and comparative measurement. Students are given the chance to practice what they have just learned by doing teacher-directed exercises in measurement.

With the first introductory units complete, students can begin work in the lab. Safety instruction is given, and the machines are demonstrated. The function of the machine is stressed over its actual operation, although both aspects are taught. The class is then divided into several small groups, and each group is sent to a teacher-designated work station. Later, students can rotate between work stations at their own discretion.

In the Core, students experience many areas. For example, they sample arc welding, oxyacetylene welding, use of the lathe, operation of drills and saws. They must complete a required number of processes, all of them exploratory. This requirement can be met in any of three ways.

First, a student may just perform the process on an appropriate piece of material. At present, these processes include: separating, forming, combining. internal modification, finishing, growing, extracting, and refining. (Further explanations of these areas, and examples of activities in them, are given later in this notebook.) For example, a student can perform separating by turning a piece on the lathe, without making that piece into a finished project. This choice is left up to the learner.

A second choice available to students is to complete the required Core number of processes by making projects which the teacher has ready and available. For example, a student can make a screwdriver and learn how to do four different processes:

	Operations	Processes
Blade -	Forging	Forming
	Grinding	Chip Removing
	Filing	Chip Removing
	Heat Treating	Internal Modification
Handle -	Turning	Chip Removing
	Drilling	Chip Removing
	Polishing	Finishing

Or the student can make a recipe box and complete five Processes:

Operations	Processes
Bending	Forming
Layout-Cutout	Separating
Spot Welding	Combining
Drilling	Chip Removing
Punching	Separating - Shearing
Riveting	Bonding, Mechanical Fastening
Soldering	Bonding

The third choice, which students may select, is to complete the required number of processes by making projects of their own. Students select the project and the teacher helps identify the processes approach.

In a program such as this, with many students working in many different areas, the teacher must make a special effort to reinforce learning and to show the relevance of the activities to the whole cluster concept. About once a week the entire group is assembled as a class. Questions are brought up and answered. Learning is reinforced and thus the quality of the program is maintained. Students benefit from each others' questions and experiences. The teacher helps the students understand WHY they are doing things as they are.

For many students in the Core, the final activity is to take several processes which they have learned and put them into one project. This activity can be a class manufacturing activity, and can even be combined between the two classes, Processes I and II. For example, a leather belt could be manufactured with one group being responsible for the leather work and the other section producing the metal buckle.

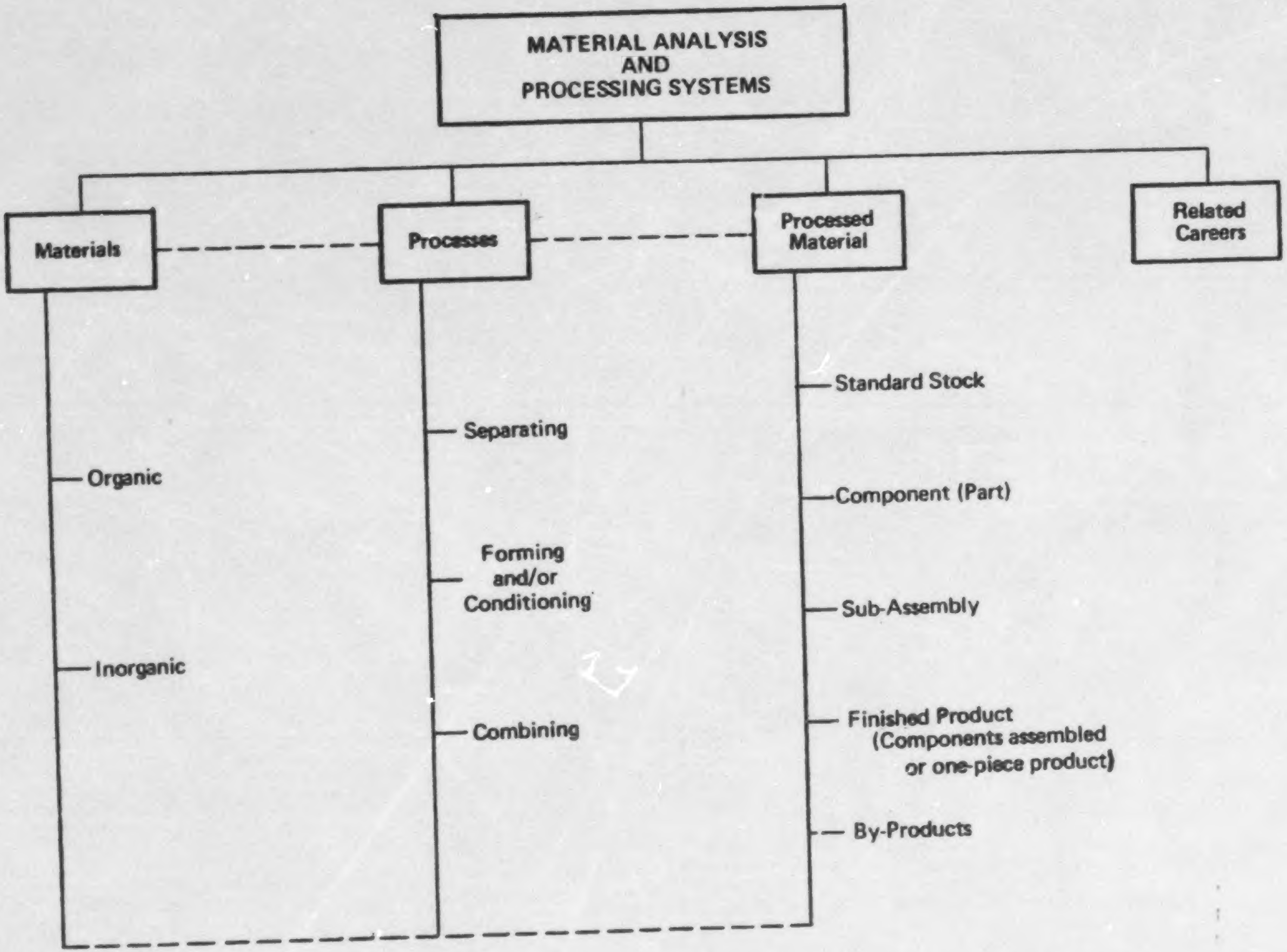
When students complete the Core, they are given the opportunity to go into the Spiral or In-Line. There they can apply the processes they have learned and make contracts for projects, or they can learn in new areas which were not introduced in the Core, such as chemical milling and glass blowing. In the Core, the teacher has more control over what the students learn; in the Spiral and In-Line, students make more of their own choices.

In summary, Materials & Processes at Shawano today uses a combination of traditional and updated content, which has been reorganized in a new "processes" method. The accent is on teaching students to become problem-solvers as well as competent machine operators. Students are taught basic processes and the means of applying them with the use of machines. The knowledge is general, and will serve as a solid building block to further learning in the Materials & Processes area.

The following materials have been taken from the SET Materials. This material is out of print and will probably not be available in the future:

Material Analysis and Processing System Chart
Goals of Material Analysis and Processing System
Activity Objectives
Performance Objectives
Content Outline
Testing Plastic Characteristics
Definition of Terms
Material Analysis and Processing Systems Test Form

taken from: Secondary Exploration of Technology (SET)
Cooperative Reasearch USD 446, 244, & 512
with Kansas State College of Pittsburg &
Title III of the State Department of Education, Topeka


MATERIAL ANALYSIS AND PROCESSING SYSTEMS
Materials
Processes
Processed Material
Related Careers
Organic
Inorganic
Separating
Forming and/or Conditioning
Combining
Standard Stock
Component (Part)
Sub-Assembly
Finished Product (Components assembled or one-piece product)
By-Products

Set.

GOALS OF MATERIAL ANALYSIS AND PROCESSING SYSTEMS

1. To develop understanding and knowledge of the properties and characteristics of all materials.
2. To develop understanding and knowledge of the systematic processes involved in changing materials.
3. To provide opportunities for attaining knowledge of vocations and avocations within the area of material analysis and processing systems.
4. To provide insight into the socio-economical and/or environmental impact of industrial processing.
5. To develop desirable attitudes and practices with respect to industrial safety standards and efficient work habits.
6. To develop knowledge, experience and understanding of the relationship between material analysis and processing systems as related to other disciplines, curriculum areas, and industry.

S.E.T.

MATERIAL ANALYSIS AND PROCESSING SYSTEMS

ACTIVITY OBJECTIVES

Upon completion of the material analysis and processing systems course:

1. The student will have participated in activities involved in changing materials by any combination of separating, forming, and/or conditioning, and combining processes as evidenced by the teacher's record of the completed activities within the designated time.
2. The student will have participated in activities involved in determining properties and characteristics of materials as evidenced by the teacher's record of the completed activities within the designated time.
3. The student will have participated in activities relating to safety standards and efficient work habits as evidenced by the teacher's record of the students completion of activities within the designated time.
4. The student will have participated in orientation and discussions of vocations and avocations relating to materials and processes as evidenced by the teacher's record of the completion of a pre-test/post-test within a designated time.
5. The student will have an opportunity to develop an insight into the socio-economical and environmental impact of industrial processing as evidenced by the teacher's records of the completion of prescribed activities within the designated time.

S.E.J.

S.E.T. Project Material Analysis and Processing Systems Curriculum

PERFORMANCE OBJECTIVES

The performance objectives listed below should provide realistic attainment levels for students enrolled in the material analysis and processing systems course described in this guide. Each teacher may wish to establish his own performance levels for the course rather than use those indicated below. However, the test instruments included in Appendix   should prove valuable regardless of teacher choice.

Performance levels are not established for the activities delineated in this guide. Each teacher using this guide is encouraged to establish performance levels for his own class per activity and to build in his own evaluation criteria.

Definitions of Performance Objectives in the Psychomotor, Affective, and Cognitive domains are included in Appendix A.

Cognitive Performance Objective

Upon exiting the S.E.T. Project Material Analysis and Processing Systems course, the students will indicate a knowledge of Material Analysis and Processing Systems as evidenced by a significant increase of 20% in mean score between pre- and post-testing on the S.E.T. Project Material Analysis and Processing Systems Curriculum test.

Affective Performance Objective

Upon exiting the S.E.T. Project Material Analysis and Processing Systems course, the students will indicate the value of the study of Material Analysis and Processing Systems as evidenced by a 15% increase in the mean score between the S.E.T. Project pre-attitude inventory and the post-attitude inventory.

Psychomotor Performance Objective

During the Material Analysis and Processing Systems course the student will perform psychomotor skills in at least the imitation and/or manipulation level as evidenced by the teachers records of successful completion of at least eight of ten teacher selected activities that suggest these levels of skill development.

CONTENT OUTLINE FOR
MATERIAL ANALYSIS AND PROCESSING SYSTEMS

Recommended Days	Activity
3	**I. ORIENTATION** A. Give pre-test to all students B. Discuss general rules, lab procedures and policies C. Introduction to General Safety D. Introduction to Industrial Technology
1	**II. ANALYSIS OF INDUSTRIAL PRODUCTS** A. Material(s) used B. Process(es) used
1	**III. INTRODUCTION TO MATERIALS** A. General Properties and Characteristics of all materials 1. Inorganic materials 2. Organic materials
5	**IV. INTRODUCTION TO PROCESSES** A. Separating processes of material B. Forming and/or conditioning of material C. Combining process of materials
14	**V. SAFETY EDUCATION AND DEMONSTRATIONS OF EQUIPMENT** A. Conduct safety demonstrations on all machines and equipment B. Administer written and proficiency test for machines and equipment C. Provide students with machine demonstration check list D. Permit forms sent home to parents
50	**VI. TEAM ACTIVITIES** A. Delineated activities using various materials and processes
15	**VII. STUDENT CONTRACT WORK** A. Each student will work on area of interest. Contract filled out by each student.
1	**VIII. CONCLUSION** A. Give post-tests to all students

90 Total Days

NOTE: The S.E.T. curriculum is designed so that school's offering full year programs may expand this document without interrupting activity continuity. Many activities are included in Section VI specifically for this purpose.

SECTION I.

ORIENTATION

DAY 1:

Provide all students with an answer sheet form and a copy of the pre-tests. (See Appendixs C & D). Have each student fill out all required information on the answer sheet form. Instruct the students that the test is to find out what they already know about material analysis and processing systems of industry.

DAY 2:

Provide all students with general rules and lab procedures and policies that they need to know and follow during the course of the year. The following is a suggested list of information that should be discussed.

1. Grading system
2. Storage of materials
3. Locker assignment
4. Seating arrangement
5. Discuss the cost of materials
6. Clean-up procedures
7. Provide students with a handout of course information and objectives
8. Policies of make-up work, absences, tardy permits, fire drills, passes from class, etc.

Discussion of general safety rules that need to be observed during the course. This can be done either by a handout list of general safety rules, films, filmstrips, or transparencies. At the completion of the period, provide a general safety test on material covered during the period.

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DAY 3:

Lecture and discussion on introduction to Industrial Technology. Relate modern industry to the study of material analysis and processing systems. Define Modern Industrial Technology as "the doing of something in the most efficient and practical way in the production of a finished product." Inform the students that they will be studying industry by completing activities that involve various materials (example--wood, metal, plastic, ceramics, rubber, etc.) and material processing. Emphasize that there may be many ways to make a product but the intended utilization of the product dictates the material uses and the processing system used.

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SECTION II.

ANALYSIS OF INDUSTRIAL PRODUCTS

DAY 4:

The instructor should select a few everyday products (examples: briefcase, tennis racket, motorcycle, car, etc.). Start the period by having the students list the names of various materials that can be found in a finished product. Also, have the student describe how they think the product was made and the processes that were performed in the fabrication of the product.

The rest of the period should be spent on discussion of the products and the materials and processes used. The students can then compare what they wrote on their paper and what was discussed during the class.

S.E.T.

SECTION III.

INTRODUCTION TO MATERIAL ANALYSIS

DAY 5:

Begin the class period with a lecture/discussion on the general properties and characteristics of all materials. Explain the terms inorganic material and organic material. (See Definition of Terms, Appendix B) Spend some time with a short demonstration by using a piece of sheet metal, wood, and styrene plastic to show the relationship of the materials and explain the general working characteristics of each. Bend the piece of wood, sheet metal, and styrene plastic to illustrate the flex strength. Materials may have chemical, environmental, thermal, electrical, optical and mechanical characteristics. Discuss characteristics of each material.

DAYS 6 - 10: INTRODUCTION TO PROCESSING SYSTEMS

Begin with a lecture/discussion of processes. Use the catagories of processes (as listed) and provide a handout of this information to all students. You may wish to make transparencies of the processes and use this for lecture and discussion. Demonstrate how all materials can be processed in similar ways. Example: Use a piece of paper and illustrate how it can be separated, formed, and combined. Relate this information to all materials. Spend the next couple of days on demonstration that last only a few minutes just to show students the relationship of processes on various materials.

SECTION IV

RELATED INFORMATION

CATEGORIES OF PROCESSES

I. FORMING AND CONDITIONING

1. Peening
2. Rolling
3. Drawing
4. Pressing
5. Forging
6. Pressing or Stamping
7. Bending
8. Extruding
9. Spinning
10. Molding
11. Vacuum Forming
12. Curing
13. Crystallizing
14. Casting
15. Heat treating
16. Melting
17. Freezing
18. Winding
19. Post-Processing (altering, installing, maintaining, repairing)

II. COMBINING

A. Mixing
    1. Beating (stirring)
    2. Agitation
    3. Atomitization

B. Finish Coating
    1. Spraying
    2. Brushing
    3. Rolling
    4. Dipping
    5. Printing
    6. Dyeing
    7. Calendar coating
    8. Electrodeposition
    9. Oxidcoating
    10. Enameling

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C. Assembling
  1. Procruement (General overview of how to get material to point of need)
  2. Fastening
    a. laminating
    b. felting
    c. welding
    d. brazing and soldering
    e. pinning
    f. shrinking
    g. pressing
    h. bonding
    i. typing

III. SEPARATING

1. Screening
2. Floating
3. Filtering
4. Magnetizing
5. Evaporating
6. Drying
7. Absorbing
8. Crushing
9. Milling
10. Turning (lathe, screw machine, chuck machine)
11. Shaping
12. Planing
13. Drilling
14. Boring
15. Broaching
16. Sawing
17. Abrading
    a. precision grinding
    b. non-precision grinding
    c. finishing
18. Shearing
19. Etching
20. Burning
21. Punching

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SECTION V

SAFETY EDUCATION AND EQUIPMENT DEMONSTRATIONS

DAYS 11-24:

Safety education is a major facet of the instructional program in industrial education. It is apparent that the industrial education teacher not only has the responsibility for giving instructions on the operation of all the machines used during the material analysis and processing systems course, but also for the development of an overall safety program for his students.

The S.E.T. Teachers recommend that in order to organize the safety program and to carry it out, the instructor must provide the following:

1. Safety demonstrations for all machines
2. Written safety test
3. Safety rules provided for general safety, machines, hand tools, etc.
4. Eye protection
5. Safety file kept for all students
6. Posters and charts
7. Visual aid resources
8. Safety permit forms (Appendix H)
9. Safety instruction form (Appendix I)
10. Proficiency test on operation of machines, equipment

A good safety program means more than the formulation and enforcement of a set of safety rules. It means that the student must have a safe environment in which to work, that safe practices must be an integral part of the training, that constant supervision must be provided. It is the responsibility of the individual teacher to organize his own safety program for the course using the required information provided in this guide. If this [illegible]vided, it will benefit not only the teacher but also the student.

SECTION VI

INDIVIDUAL AND/OR GROUP ACTIVITIES

DAYS 25-74:

It will be the instructor's responsibility to organize and plan student activities selected from this guide. Although all the activities provided in this guide cannot be covered in the short length of time, it is up to the individual teacher to carefully select those activities that can be covered using materials and equipment on hand. The information provided on the following activities provide the instructor with the name of the activity, material and processes covered, reference materials needed, and other information necessary to complete the activity. Some of the activities will require a teacher demonstration before a student can perform the particular activity. This decision will have to be made by the individual teacher.

One method of completing the included activities is to establish a specific number of days for the metal process activities, a specific number of days for the wood activities, etc. Another method would be to select all combining activities and specify the number of days required to complete the activities. The same procedure could be followed with the forming, separating, and conditioning processes. However, the final decision will be left up to the teacher using this guide.

At the completion of each activity, the student should complete the Process Evaluation Form (Appendix J). The student presents the form to the instructor for final evaluation of the completed activity.

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It may prove advantageous to allow two students to work together on each activity. The team approach allows the students to help each other as they complete the activity. The approach also proves helpful when one student is absent from school, and as a result, misses a demonstration. The non-absent student can relate the demonstration to his partner thereby allowing him to complete the activity.

S.E.T.

LAB ACTIVITY

PROPERTIES AND CHARACTERISTICS OF VARIOUS PLASTICS

FROM: SET Material
Kansas State College
and
Kansas State Department of Education

PROCESS: FORMING AND/OR SEPARATING
MATERIAL: PLASTIC

ACTIVITY
"Testing Plastic Characteristics"

Allow 1 class period

OBJECTIVE: At the conclusion of this activity the student will be able to identify a minimum of ten types of plastics as evidenced by successfully completing the form provided.

EQUIPMENT AND SUPPLIES NEEDED: Matches, soldering iron, test tubes, test tube stand, plastic sample strips ½" x 5"

REFERENCE MATERIAL: PLASTIK-LAB--Student Workbook

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material on properties and characteristics of plastics.
   - B. Provide each student with an answer sheet form (see Figure B included)
2. Teacher Demonstration
   - A. Using pre-selected samples of thermo-set material and thermo-plastic material demonstrate the procedure which should be followed in the various tests of material.
3. Student Activity
   - A. Identify 10 pieces of plastic material by following the procedure list and information presented by the instructor.

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PROPERTIES AND CHARACTERISTICS OF VARIOUS PLASTICS

(c) Plastik/Labs, Wichita, Kansas

IDENTIFYING PLASTICS

Plastics may be identified by a number of different tests. One's knowledge of resins and their particular application can be used as a basis for identifying a resin. Feel, smell and sight may also give a person an indication of a certain plastic. Certain solvent tests can be performed on unknown plastics to help in identifying them. Measuring the specific gravity of a plastic will also aid in identifying the item. These tests, however, will give only an indication as to the correct identity. Infrared spectroscopy is the only accurate method of identifying an unknown plastic resin. X-ray emission determines the individual elements comprising the sample.

The "match test" is one of the best simple tests to determine the type of an unknown plastic. The test involves holding a flame under the unknown plastic and observing if the material burns, color of the flame, any smoke present, odor given off, any dripping of the material and if the material will continue to burn if the flame is removed. This simple test is the most reliable test with the exception of infrared spectroscopy.

THE MATCH TEST

The chart in figure A has been provided to help you identify the sample's burning characteristics. When you have identified a sample, place the correct name in the chart in figure B. The plastic material should have a code number on it. Place the code number opposite of the name of the plastic material.

STEP 1. Select a sample.

STEP 2. Using a soldering iron, see if the sample will melt. A thermoset plastic will not melt, but a thermoplastic will.

STEP 3. When the sample has been identified as either thermoplastic or thermoset, you will be able to proceed on to either the right columm or the left column of the chart in figure A.

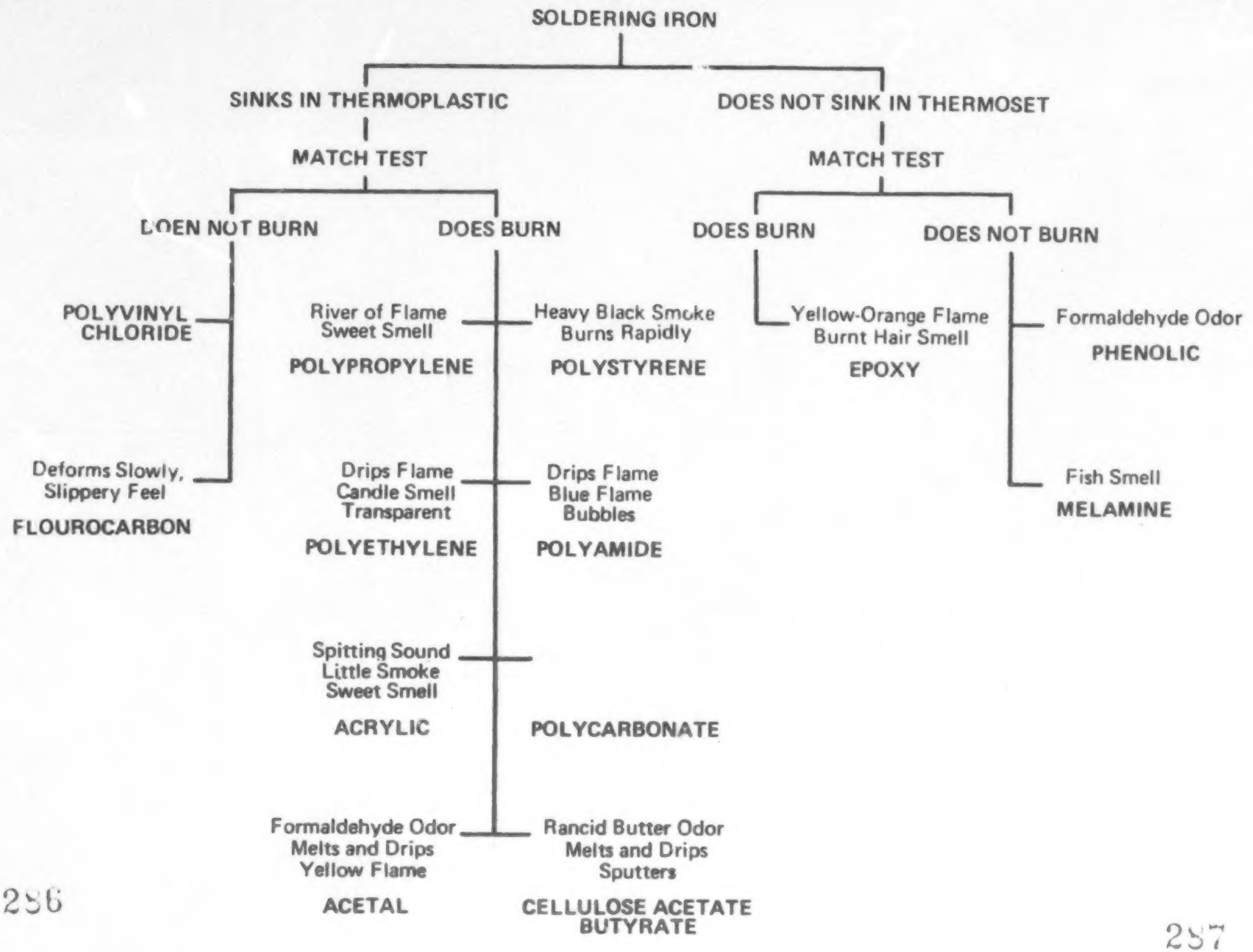
STEP 4. Strike a match to determine whether the material will burn or not burn. Whether it burns or not determines which column on the chart you must follow.

STEP 5. Observe the burning characteristics and determine the unknown sample's correct name.

(c) Plastik/Labs, Wichita, Kansas

STEP 6. Perform the same test on each of the 13 samples. USE CAUTION WHEN BURNING A PIECE OF PLASTIC.

As an example, let's take the plastic, polyester. When we apply the soldering iron to polyester, it does not melt. This indicates that it is a thermoset and we must use the chart to the right. When a burning match is placed under the sample, the material burns. This means that we must follow the column "does burn." The characteristics of polyester are that it ignites rapidly, black carbon is given off, a sweet odor is given off and the resin is self-extinguishing when the flame is removed. Keep in mind that there are many other plastic resins that can be identified by burning. The chart shows only the most common resins.


SOLDERING IRON
SINKS IN THERMOPLASTIC
DOES NOT SINK IN THERMOSET
MATCH TEST
MATCH TEST
DOES NOT BURN
DOES BURN
DOES BURN
DOES NOT BURN
POLYVINYL CHLORIDE
River of Flame Sweet Smell
POLYPROPYLENE
Heavy Black Smoke Burns Rapidly
POLYSTYRENE
Yellow-Orange Flame Burnt Hair Smell
EPOXY
Formaldehyde Odor
PHENOLIC
Deforms Slowly, Slippery Feel
FLOUROCARBON
Drips Flame Candle Smell Transparent
POLYETHYLENE
Drips Flame Blue Flame Bubbles
POLYAMIDE
Fish Smell
MELAMINE
Spitting Sound Little Smoke Sweet Smell
ACRYLIC
POLYCARBONATE
Formaldehyde Odor Melts and Drips Yellow Flame
ACETAL
Rancid Butter Odor Melts and Drips Sputters
CELLULOSE ACETATE BUTYRATE

(c) Plastik/Labs, Wichita, Kansas

THE STORY OF THE PLASTIC INDUSTRY, pages 6-7

Plastics: What They Are

Plastics are man-made materials, in contrast to nature's materials like wood and metal. A generally accepted definition is: Any one of a large and varied group of materials consisting wholly or in part of combinations of carbon with oxygen, hydrogen, nitrogen and other organic and inorganic elements which, while solid in the finished state, at some stage in its manufacture is made liquid, and thus capable of being formed into various shapes, most usually through the application, either singly or together, of heat and pressure.

Plastics are a family of materials--not a single material--each member of which has its special advantages.

Being man-made, plastic raw materials are capable of being variously combined to give most any property desired in an end product. But these are controlled variations unlike those of nature's products.

The widespread and growing use of plastics in almost every phase of modern living can be credited in large part to their unique combinations of advantages. These advantages are light weight, range of color, good physical properties, adaptability to mass-production methods and, often, lower cost. Some plastics can be sterilized.

Aside from the range of uses attributable to the special qualities of different plastics, these materials achieve still greater variety through the many forms in which they can be produced.

They may be made into definite shapes like dinnerware and electric switchboxes.

They may be made into flexible film and sheeting familiar as shower curtains and upholstery.

They may be made into sheets, rods and tubes that are later shaped or machined into internally-lighted signs, airplane blisters.

They may be made into filaments for use in household screening, industrial strainers and sieves.

They may be made into netting in a variety of patterns and sizes.

They may be used as a coating on textiles and paper.

They may be used to bind together such materials as fibers of glass and sheets of paper or wood to form boat hulls, airplane wing tips and table tops.

They may be used as adhesives, and in lacquers and paints--uses which are but mentioned in this booklet which deals specifically with solid forms of plastics.

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Whatever their properties or form, plastics all fall into one of two groups--the *thermoplastic* or the *thermosetting.*

Definitions:

Thermoplastic:

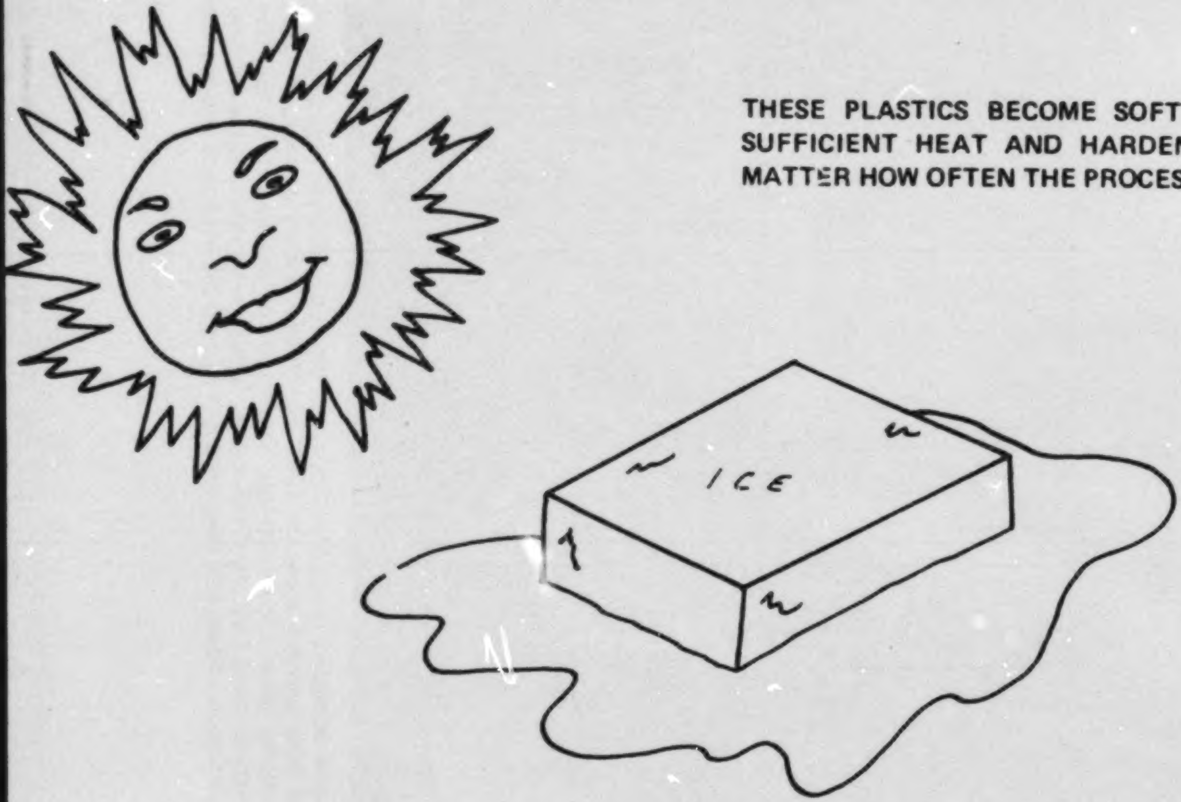
These plastics become soft when exposed to sufficient heat and harden when cooled, no matter how often the process is repeated. In this group fall ABS (acrylonitrile-butadiene-styrene), Acetal, Acrylic, the cellulosics, ethylene-vinyl acetate, fluorocarbon, ionomer, nylon, parylene, phenoxy, polyallomer, polycarbonate, polyethylene, polyphenyl oxide, polyimide, polypropylene, polystyrene, polysulfone, urethane. and vinyl.

Thermosetting:

The plastics materials belonging to this group are set into permanent shape when heat and pressure are applied to them during forming. Reheating will not soften these materials. Thermosetting plastics include: alkyd, amino (melamine and urea), casein, cold molded, epoxy, phenolic, polyester, and silicone.

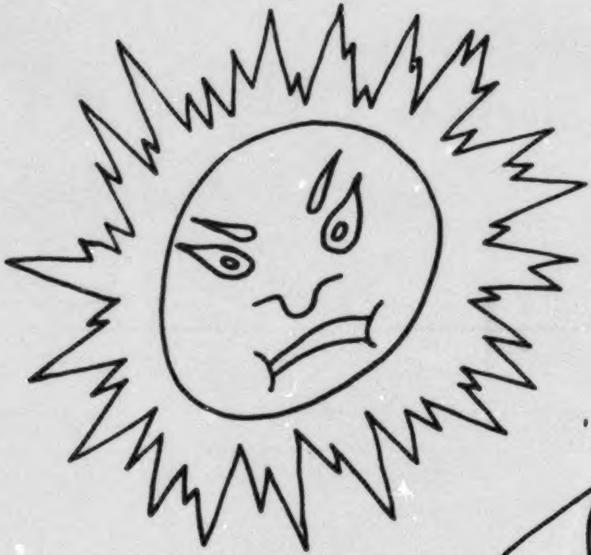
THERMOPLASTIC

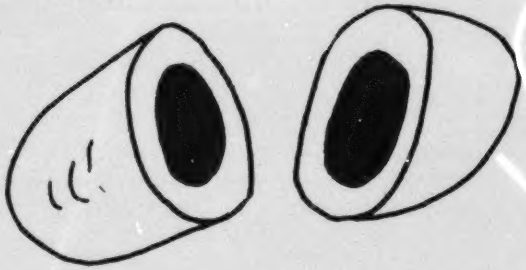
THESE PLASTICS BECOME SOFT WHEN EXPOSED TO SUFFICIENT HEAT AND HARDEN WHEN COOLED, NO MATTER HOW OFTEN THE PROCESS IS REPEATED.



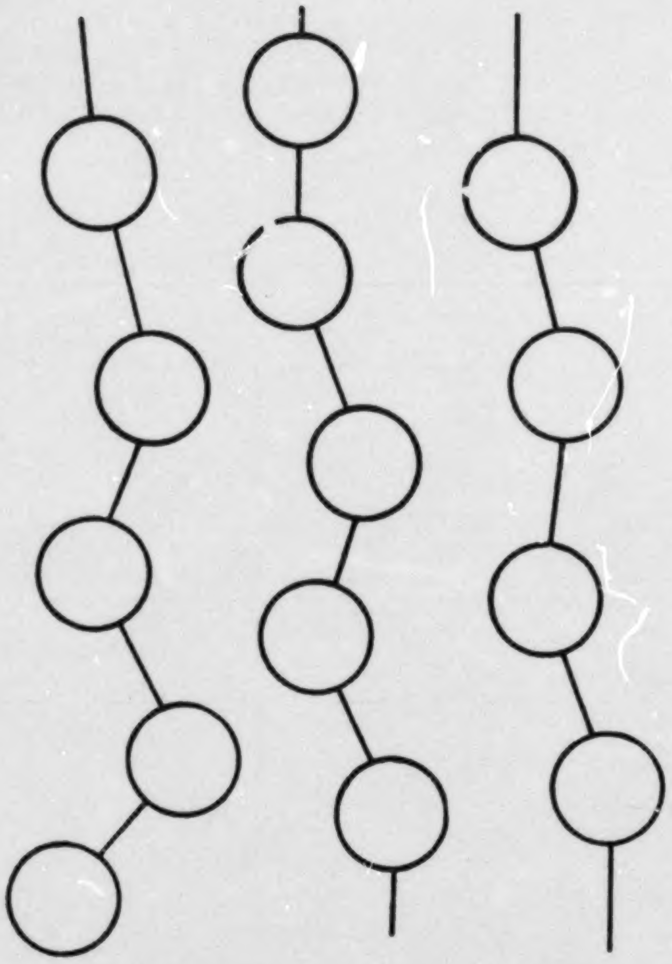
THERMOSETTING

THE PLASTICS MATERIAL BELONGING TO THIS GROUP ARE SET INTO PERMANENT (USUALLY RIGID) SHAPE WHEN HEAT AND PRESSURE ARE APPLIED TO THEM DURING FORMING.

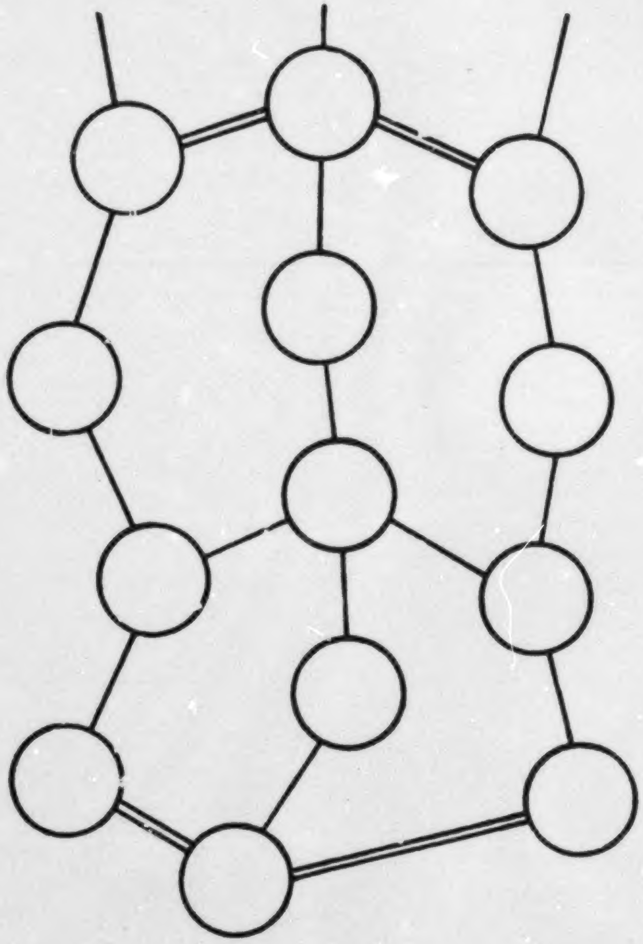




PLASTIC STRUCTURE



THERMOPLASTIC



THERMOSETS

RESIN	THERMOSET OR THERMOPLASTIC	SPECIAL PROPERTIES	APPLICATIONS
Polyester		1. 2.	1. 2.
Polystyrene		1. 2.	1. 2.
Fluorocarbon		1. 2.	1. 2.
Epoxy		1. 2.	1. 2.
Polycarbonate		1. 2.	1. 2.
Polyethylene		1. 2.	1. 2.
Phenolic		1. 2.	1. 2.
Acetal		1. 2.	1. 2.
Cellulosics		1. 2.	1. 2.
Vinyl		1. 2.	1. 2.
Polyurethane		1. 2.	1. 2.
Polypropylene		1. 2.	1. 2.
Polyamide		1. 2.	1. 2.
Acrylic		1. 2.	1. 2.
Melamine		1. 2.	1. 2.

DEFINITION OF TERMS

MATERIAL ANALYSIS AND PROCESSING SYSTEMS--is the study of organic and inorganic materials and how they are changed to satisfy man's material needs.

MATERIAL DEFINITION:

ORGANIC MATERIAL--those materials pertaining to or derived from living organisms. Example of organic material: wood, leather, paper, textiles, plastics, rubber, petroleum, natural gas, etc.

INORGANIC MATERIAL--those materials that are matter other than animal or vegetable. Examples of inorganic materials: ceramics, clay, glass, enamel, concrete, stone,.etc.

PROCESS DEFINITION:

COMBINING PROCESS--is any number of methods that involves the joining of material together permanently or semi-permanently and the treating of the surface of a material for the primary purpose of appearance and/or protection.

SEPARATING PROCESS--is any number of processes that involves the cutting or removing of pieces of material from a base material by using a wide range of hand and machine tools and also by the use of heat and various chemicals.

FORMING AND/OR CONDITIONING PROCESS--is any number of processes that involve imparting a specific shape or cross section to a material without adding or removing any of the material. This process is used for the purpose of achieving a desired configuration and also results in a stronger product.

CHANGED MATERIALS DEFINITION:

STANDARD STOCK--material or stock that requires further processes before being useful to the consumer.

STANDARD PART OR COMPONENT--a part or component requiring no further processes except assembly.

SUB-ASSEMBLY--standard part or components combined to produce sections of a finished product.

FINISHED PRODUCT--a completed consumer product

ASSEMBLY--combination of sub-assemblies and/or components

BY-PRODUCT--the recycling of rejected or reuseable standard parts components.

SET.

S. E. T.

MATERIAL ANALYSIS AND PROCESSING SYSTEMS TEST

PLACE ALL ANSWERS ON ANSWER SHEET!

1. An arc welder is best suited for:

   A. forming
   B. combining
   C. separating
   D. conditioning

2. Which of the following products should be conditioned?

   A. screwdriver
   B. bread board
   C. candle holder
   D. tool box

3. Steel is:

   A. a natural material
   B. an organic material
   C. an alloy
   D. an element

4. A process of heating steel and then hammering it to some shape is known as:

   A. casting
   B. milling
   C. forging
   D. separating

5. A metal that contains little or no iron is known as:

   A. ferrous
   B. non-ferrous
   C. an alloy
   D. a compound

6. Which of the following processes can not easily be performed on cast iron?

   A. filing
   B. cutting
   C. bending
   D. drilling

7. Steel is not:

   A. magnetic
   B. corrosion resistant
   C. a ferrous material
   D. an alloy

8. Recycling of metal products is done to:

   A. reduce labor costs
   B. produce higher quality materials
   C. conserve natural resources
   D. all of these

9. Name a use for the by-products of the steelmaking process:

   A. plywood construction
   B. substance in asphalt road covering
   C. paper laminating
   D. gasoline distillation and condensation

10. Which of the following processes does involve material loss?

    A. punching a hole in sheet metal
    B. drilling a hole in sheet metal
    C. cutting sheet metal with a tinsnips
    D. bending sheet metal with the barfolder

11. The hardness of steel depends on:

    A. primary alloy
    B. aluminum
    C. its shape
    D. the carbon content

12. The existance of carbon in steel determines its ability to:

    A. be heat treated
    B. conduct electricity
    C. radiate heat
    D. be magnetized

13. The chemical element considered to be the backbone of plastic is:

    A. Oil
    B. Wood
    C. Carbon
    D. Water

14. Upon heating, _______ material will soften and then harden when they are cooled.

    A. Thermoplastic
    B. Thermosetting
    C. Synthetic
    D. Wood

15. _______ material form a cross-link between adjacent molecules, usually during molding, that will prevent the plastic flow with the addition of heat.

    A. Thermoplastic
    B. Thermosetting
    C. Synthetic
    D. Wood

16. _______ is a process of forming where a plasticized thermoplastic material is injected or forced under pressure into a closed mold where it cools to form a product.

    A. Extrusion Molding
    B. Injection Molding
    C. Compression Molding
    D. Foam Molding

17. A process of molding in which thermoplastic materials are shaped by forcing them through a die orifice to produce a continous shaped rod, wire, cable, etc. is

    A. Extrusion Molding
    B. Injection Molding
    C. Transfer Molding
    D. Rotational Molding

18. Blow molding was originally developed to produce

    A. glass containers
    B. expoxy resin
    C. polystryene beads
    D. solvent cement

19. Drilling, boring and reaming are separating processes that can be performed on the _______, given proper attachments.

    A. radial arm saw
    B. metal lathe
    C. drill press
    D. all of above

20. ______________ is a process of forming a hollow seamless object by the use of liquid or powder placed in a hollow mold and moved on two axes.

A. Foam Molding
B. Injection Molding
C. Transfer Molding
D. Rotational Molding

21. Products such as 4' x 8' sheets of glass or 10' lengths of galvanized pipe are classified as:

A. components
B. standard stock
C. subassemblies
D. by-products

22. ______ is a process of forming a thermoplastic material by heat or pressure.

A. Thermoforming
B. Casting
C. Coating
D. Lamination

23. Waste material from injection molding can be reused because it is a ______ material.

A. thermoplastic
B. thermosetting
C. coating
D. casting

24. A milling machine is used to perform __________ operations on metals.

A. separating
B. combining
C. forming
D. conditioning

25. ______ refers to any of a number of processes in which a liquified material is poured into a suitable mold and solidifies to form the product.

A. thermoforming
B. heating
C. curing
D. casting

26. The chemical that triggers the resin and causes it to set up hard is called:

A. acetals
B. catalyst
C. solvent
D. urea

27. Prolonged heating of a plastic such as the acrylics at temperatures lower than those used for forming followed by slow cooling is called:

A. annealing
B. curing
C. welding
D. stamping

28. Screening, floating and filtering are examples of:

A. separating
B. combining
C. forming
D. conditioning

29. Dip molding processes makes use of which one of the following types of molds:

A. an internal mold
B. a hollow mold
C. an external mold
D. all of the above

30. Slush molding makes use of a ______________ filled with plastisol.

A. an internal mold
B. an external mold
C. hollow heated mold
D. none of the above

31. Post-processing activities include:

A. conditioning and finishing
B. coating and polishing
C. assembly and packaging
D. installing and maintaining

32. Most high pressure lamination is done on the:

A. rotational molder
B. extrusion molder
C. injection molder
D. compression molder

40. Heating a metal rod and allowing it to cool slowly so that it can be shaped is an example of:

A. compressing or stretching
B. conditioning
C. shearing and fracturing
D. coating or bonding

41. A finished product such as a radio may be classified as:

A. a component
B. a sub-assembly
C. a part
D. an assembly

42. None of the material is lost along the parting lines during:

A. sawing
B. drilling
C. sanding
D. shearing

43. Filing the rough edge from a casting is an example of:

A. shearing
B. chip removal
C. thermal erosion
D. conditioning

44. Man-made materials are called:

A. extractive
B. synthetic
C. reproducible
D. none of these

45. Which is not a basic way of forming material?

A. casting
B. compressing
C. stretching
D. chip removing

46. _________ is a process of building up the thickness or width of material by placing several layers of materials together.

A. casting
B. lamination
C. bonding
D. thermoforming

33. A one-piece product may be a_______of a larger product, or a

A. component, finished product
B. subassembly, standard stock item
C. part, subassembly
D. by-product, component

34. Two primary molding methods of reinforced molding are:

A. low pressure, open molding
B. high pressure, transfer molding
C. casting, low pressure
D. slush molding, static molding

35. ________and________ are the names of two types of fiberglass materials that can be used for reinforced plastic molding

A. film, sheet
B. resin, cloth
C. mold release, mat
D. cloth, mat

36. _________is the principal resin involved in the manufacture of expandable beads which contains a gas which will expand when heat is applied.

A. polyurethane
B. polystyrene
C. cellulose acetate
D. epoxy

37. ____________is used for bonding together of thermoplastic material.

A. epoxy cement
B. silicone adhesive
C. solvent cement
D. all of the above

38. The term abrading applies to the separating process of:

A. milling
B. precision grinding
C. etching
D. planing

39. Forging, bending, and drawing are all material forming processes of which type?

A. casting or molding
B. conditioning
C. compressing or stretching
D. chip removing

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47. _____________ is a process of coating a wood to improve its appearance by changing its color, bring out the grain oresserve it and sometimes to imitate the more expensive woods.

A. staining
B. filling
C. bonding
D. polishing

48. _________________________ is a bonding process where two materials are rotated at a high rate of speed against each other and this causes heat which will melt the plastic and fuse it together.

A. fusion welding
B. friction welding
C. gas welding
D. heat sealing

49. _________________________ is a process where a nichrome wire is heated for only a few seconds to soften the plastic, and then the wire cools under pressure to form a excellent narrow seal.

A. dielectric sealing
B. friction welding
C. fussion welding
D. impulse sealing

50. To apply by hand successive layers of glass cloth and resin is a process called:

A. lay-up
B. parison
C. orifice
D. casting

S.E.T. PROJECT MATERIAL ANALYSIS AND PROCESSING SYSTEMS CURRICULUM ANSWER SHEET

DATE __________ HOUR __________ NAME ______________________________

CLASS ______________ STUDENT # ______________________________

INSTRUCTIONS:

Circle or black out the letter of the correct response; choose only the one best answer. Make no marks on the test. Mark all answers on this sheet.

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D
9. A B C D
10. A B C D
11. A B C D
12. A B C D
13. A B C D
14. A B C D
15. A B C D
16. A B C D
17. A B C D
18. A B C D
19. A B C D
20. A B C D
21. A B C D
22. A B C D
23. A B C D
24. A B C D
25. A B C D
26. A B C D
27. A B C D
28. A B C D
29. A B C D
30. A B C D
31. A B C D
32. A B C D
33. A B C D
34. A B C D
35. A B C D
36. A B C D
37. A B C D
38. A B C D
39. A B C D
40. A B C D
41. A B C D
42. A B C D
43. A B C D
44. A B C D
45. A B C D
46. A B C D
47. A B C D
48. A B C D
49. A B C D
50. A B C D

KEY FOR MATERIAL ANALYSIS AND PROCESSING SYSTEMS
PRE–POST TEST

Correct Responses:

1. B   2. A   3. C   4. C   5. B   6. C   7. B   8. C   9. B
10. B   11. D   12. A   13. C   14. A   15. B   16. B   17. A   18. A
19. D   20. D   21. B   22. A   23. A   24. A   25. D   26. B   27. A
28. A   29. A   30. C   31. D   32. D   33. A   34. A   35. D   36. B
37. D   38. B   39. C   40. B   41. D   42. D   43. B   44. B   45. D
46. B   47. A   48. B   49. D   50. A

The instructor should evaluate each pre-test and record the results for comparison with the overall test results to find possible areas of strengths and weaknesses in the class. The post-test results should be compared to the pre-test to see if the performance objective was met.

MATERIAL ANALYSIS AND PROCESSING SYSTEMS FORM

INSTRUCTIONS: In order to evaluate the completion of the required activity, fill out all the information provided on this form and hand to the instructor. This form will be kept by the instructor in order to provide proof of the completion of each activity.

STUDENTS NAME ______________________________ Class Period ________

State the name of each process that was performed during the activity. Example: casting, lamination, compression molding, etc. ______________________________

____

____

____

Estimated time for completion of activity: ______________________________

Give the correct name of the material or materials that were used for the activity. Example: black walnut, aluminum alloy, acrylic plastic, etc. ______________________________

____

____

1. Organic
2. Inorganic

The material used for this activity is classified as: Circle correct answer

1. Thermoplastic
2. Thermosetting

1. Hardwood
2. Softwood

1. Non-ferrous metals
2. Ferrous metals

1. Others (state):

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S.E.T.

The following attachments describe the Utah State IA Career Exploration material, in part, is being commercially developed. For information pertaining to availability and cost contact:

Joe O. Luke
Industrial Arts Specialist
Utah State Board of Education
250 East Fifth South
Salt Lake City, Utah 84111

A total of **forty-five** Level One career modular units have been developed.

The units are:

CONSTRUCTION

- Architect
- Bricklayer
- Cabinet Maker
- Carpenter
- Cement Mason
- Dry-wall Applicator
- Electrician
- Glazier
- Plumber
- Surveyor
- Tile Setter

TRANSPORTATION

- Aerospace Engineer
- Aircraft Designer
- Airplane Pilot
- Auto-body Repairer
- Auto Service Station Attendant
- Bicycle Repairer
- Gas Engine Repairer
- Boat Builder
- Auto Service Mechanic
- Electrical Motor Repairer

MANUFACTURING

- Electric Appliance Repairer
- Electronics Assembler
- Foundry Worker
- Furniture Upholsterer
- Jeweler
- Leather Worker
- Machinist
- Metallurgist
- Hand Ceramic Molder
- Ornamental Iron Worker
- Ornamental Metal Worker
- Electroplater
- Sports Equipment Repairer
- Sheet Metal Worker
- Textile Worker
- Combination Welder
- Fly Tyer
- Plastics Worker

INDUSTRIAL COMMUNICATION

- Announcer
- Compositor
- Drafter
- Illustrator
- Sign Painter
- Photographer
- Screen Printer

A CAREER ACTIVITY PACKAGE SYSTEM (CAPS) has been developed for Level II and Level III. The CAREER ACTIVITY PACKAGES for Level II are simple, pre-designed, individualized career activities.

The CAREER PACKAGES include:

- Career related information
- Student project or activity directions
- Career evaluation

The CAREER ACTIVITY PACKAGES are supported by:

- Machinery operation packets (MOPS)
- Power tool references (PTR)
- Machinery information references (MIR)
- Hand tool references (HTR)

The machinery operation packets include:

- Machine Description
- Film Reference(s)
- Text Reference(s)
- Machine Nomenclature
- Machine Adjustments
- Machine Operations
- Safety Test
- Teacher "Check-out"

The power tool references include:

- Power Tool Description
- Power Tool Operation Directions
- Power Tool Nomenclature
- Text Reference(s)
- Safety Rules
- Safety Test
- Teacher "Check-out"

The machinery information references include:

- Machine Description
- Machine Operation Directions
- Text References
- Machine Nomenclature
- Safety Rules
- Safety Test
- Teacher "Check-out"

The hand tool references include:

- Picture of Hand Tool
  - Utilization
    - Text Reference

Level III incorporates more **complex pre-designed CAREER ACTIVITY PACKAGES** and provides a system for advanced students to research and design their own personal career related projects and activities.

The new CAREER EXPLORATION program also incorporates an individualized **mass-production** system.

This system includes:

- A mass-production center (bench)
- Individualized procedure manuals
- Coordinated with an audio tape

The PRODUCTION CAREERS are:

- President
- Safety Engineer
- Plant Manager
- Accountant
- Quality Control
- Foreman
- Cut Off Operator
- Drill Operator
- Assembler
- Power Sander
- Hand Sander
- Stainer
- Finisher
- Burnisher
- Packager
- Labeler

The IACE program was developed by a consortium of seven Utah school districts; Davis, Granite, Iron, Logan, Nebo, Washington, and Weber and Utah State University Industrial and Technical Education department under the direction of the State Board for Vocational Education.

The instructional modular on display at the Commissioner's National Conference for Career Education were constructed by Granite School District.

For further information contact:

Joe O. Luke
Industrial Arts Specialist
Utah State Board of Education
250 East Fifth South

Utah State Board for Vocational Education

ia

CAREER EXPLORATION

THE INDUSTRIAL ARTS CAREER EXPLORATION PROGRAM (IACE)

The Industrial Arts Career Exploration program is a mixture of **Career** and **Industrial Arts** Education. The program is organized around the industrial-based **cluster** concept to provide individualized student centered, hands-on learning experiences which effectively meet the needs of junior high school students.

The clusters are:

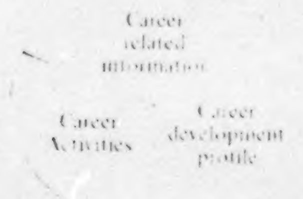
Construction	Industrial communication
Manufacturing	Transportation

The learning activities are

- Relative with industrial tools, equipment, materials, processes and techniques.
- Designed to incorporate multiple instructional strategies.
- Designed for successful hands-on experiences.
- Developed in accordance with physical and intellectual growth patterns and individual differences.
- Designed sequentially from simple to complex.
- Designed to encourage student initiative and personal responsibility.
- Designed for elective non-graded student enrollment.
- Co-educational

The IACE curriculum incorporates **three** dimensions of learning.

The dimensions of learning are



The CAREER RELATED INFORMATION provides the students with information about careers within the clusters. The information is directly related to the career activity experience of the program.

This information is based on the following criteria:

- What is the occupation all about?
- What, exactly, does the person do?
- What is the working environment?
- What are the education and training requirements?
- What are the job prospects?
- What are the likely salary ranges?

The CAREER ACTIVITIES are developed around the occupations of each career cluster.

Career activities are divided into two categories:

- Useful student projects
- Industrial simulations

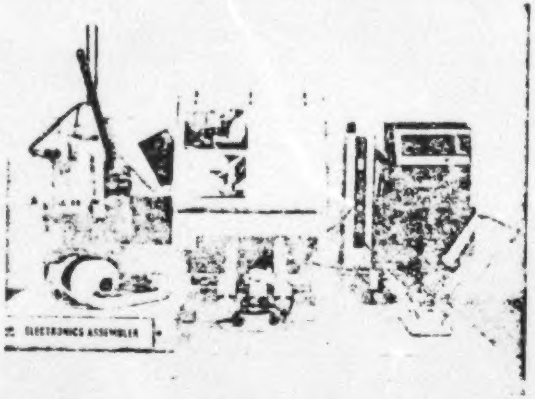
The CAREER DEVELOPMENT PROFILE emphasizes:

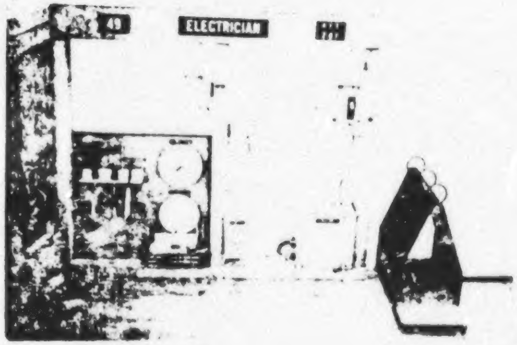
- The relationship of each occupation identified with a career activity to **data, people,** and **things.**
- Identification of **likes** or **dislikes** toward each career activity, and
- Encourages students to start formulating a **career identity.**

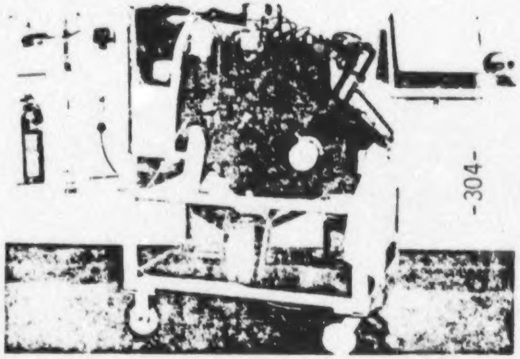
The new CAREER EXPLORATION program has three sequential levels: a **modular structure** concept has been incorporated for Level I.

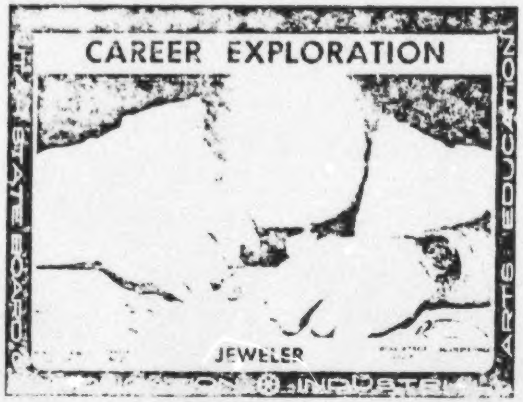
The modular units include a:

- Self contained tool carrel (see picture No. 1)
- construction section, or (see picture No. 2)
- mock-up, with (see picture No. 3)
- pictorial procedure manual (see picture No. 4)
- coordinated with an audio tape









August 23, 1978

CAPS Available 1976 - 1978

#1	Aerospace Engineer	
	1.1E-78	Rocket from Scratch
#2	Aircraft Designer	
	2.1E-76	Balsa Airplane Kits (3)
#4	Auto-Body Repairer	
	4.1E-76	Pull a Dent
	4.2E-76	Shrink a Spot
#5	Auto Service Station Attendant	
	5.1E-76	Auto Checklist and Inspections
	5.2E-76	Spark Plug Removal
#8	Boat Builder	
	8.1E-76	Catamaran Boat
#11	Automotive Designer	
	11.1E-78	CO_2 Car
#15	Drafter	
	15.1E-77	Drawing an Orthographic Projection
#17	Sign Painter	
	17.1E-76	Name Sign
	17.2E-76	Address Sign
	17.3E-76	Rubber Stamp
#20	Screen Printer	
	20.1E-76	Making a Silk Screen (Stencil)
#25	Electrical Appliance Repairer	
	25.1E-76	Install Socket, Cord and Plug on a Lamp
	25.2E-78	Small Electric Motor
#26	Electronics Assembler	
	26.1E-78	Crystal Radio
	26.4E-78	Electric Buzzer
#27	Foundry Worker	
	27.1E-76	Wall Plaque

#28 Furniture Upholsterer

28.1E-76	Bucket Chair
28.2E-76	Exercise Board
28.3E-78	Kitchen Chair Seat

#29 Jeweler

29.1E-78	Cabachon
29.2E-78	Ring
29.3E-78	Bracelet
29.4E-78	Tumbling
29.5E-78	Lost Wax

#30 Leather Worker

30.1E-76	Stamped Belt
30.2E-76	Coin Purse
30.3E-76	Tooled and Laced Wallet
✓30.4E-78	Wallet From Scratch
✓30.5E-78	Knife Sheath
30.6E-78	Photo Album
✓30.7E-78	Rifle Sling
✓30.8E-78	Pistol Holster
✓30.9E-78	Axe Sheath
✓30.10E-78	Bullet Belt

#31 Machinist

31.1E-76	Soft-Faced Hammer
31.2E-76	Fly Tying Vise
✓31.3E-78	Meat Tenderizer
✓31.4E-78	Bow Saw
✓31.5E-78	Fly Tying Half Hitch Tool

#32 Metallurgist

32.1E-77	Screwdriver

#33 Ceramics Caster

✓33.1E-78	Slip Casting

#34 Ornamental Iron Worker

34.1E-77	Wiener Roaster
34,2E-77	Candelabra
34.3E-77	Wall Shelf
34.4E-77	Power Cord Hanger
34.5E-77	Hanging Plant Holder
✓34.6E-77	Candle Holder
34.7E-77	Hanging Wall Lamp
34.8E-78	Fireplace Holder
34.9E-78	Log Tongs
✓34.10E-78	Take Down Weiner Roaster (see also Welder 40.10E-78)
✓34.11E-78	Dutch Oven Lifter

#37 Sports Equipment Repairer

37.1E-76	Archery Target (glue up)
37.2E-76	Arrow Making
37.3E-78	Water Ski

#38 Sheet Metal Worker

38.1E-76	Tool Box Tray
38.2E-76	Tool Box
38.3E-77	Dust Pan
38.4E-77	Scoop
38.5E-77	Cookie Sheet
38.6E-77	Parts Storage Cabinet
38.7E-77	Tote Box
38.8E-77	Pet Feeders (large, medium, small)
38.9E-77	Reflector Oven
38.10E-77	Strong Box (large, medium, small)
38.11E-77	Tool Box
38.12E-77	Paper Organizer
38.13E-77	Dust Pan
38.14E-78	Dust Pan
38.15E-78	Tool Tray
✓38.16E-78	Parts Tray
✓38.17E-78	Hanging Lamp

#39 Textile Worker

39.1E-78	Rug
39.2E-78	Ski Cap
✓39.3E-78	Stuff Bag
✓39.4E-78	Scarf

#40 Welder

40.1E-76	Flangeweld
✓40.5E-78	Garden Shovel
✓40.6E-78	Kudual Stick
40.7E-78	Trailer Jack
40.8E-78	Cycle Repair Stand
40.9E-78	Glass Top Table
✓40.10E-78	Wiener Roaster

#41 Fly Tyer

41.1E-76	Tying a Wolly Worm
41.2E-76	Tying a Renegade
41.3E-76	Tying a Royal Coachman

#42 Plastics Worker

42.1E-76	Making a Teardrop
42.2E-76	Pen Set
42.3E-77	Salt and Pepper Shakers
42.4E-77	Pen and Pencil Holder
✓42.5E-78	Tic-Tac-Toe
✓42.6E-78	Cutting Board
✓42.7E-78	Axe Handle Repair
✓42.8E-78	Insulated Thermos Jar
✓42.9E-78	Coin Purse

#45 Cabinet Maker

45.1E-76	Wall Gun Rack
45.2E-76	Penny Hockey
45.3E-76	Hand Mirror
45.4E-76	Handle for Soft-Faced Hammer (Machinist Cap #31.1E-76)
✓45.5E-78	Train Set
✓45.6E-78	Stirring Spoon
45.7E-78	Storage Shelf
45.8E-78	Mom's Board of Education
45.9E-78	Sewing Box
✓45.10E-78	Bongo Board
45.11E-78	Foot Stool
✓45.12E-78	Letter and Pen Holder
45.13E-77	Live Trap
45.14E-77	Balancing Bird
45.15E-77	Chess Board
✓45.17E-78	Golf Tee
45.18E-77	Vegetable Slicer
45.19E-77	Light Box Lamp
45.20E-77	Book Rack
45.21E-77	Quilting Frame Stand
✓45.22E-78	Jewelery Box
✓45.23E-78	Laminated Cutting Board
✓45.24E-78	Wooden Clock
✓45.25E-78	Night Stand
✓45.26E-78	One Piece Cutting Board
45.27E-78	Cholla Lamp

#46 Carpenter

46.1E-76	Well Pot Holder

#49	Electrician	
	49.1E-76	Wiring a Light to Two 3-Way Switches
	49.2E-76	Wiring one Light, Single Pole Switch, and a Convenience Outlet
#50	Glazier	
	50.1E-76	Cut and Set Mirror (Cabinet Maker 45.3E-76)
	50.2E-76	Aluminum Framed Mirror
	50.3E-76	Aluminum Frame Tack Board
	50.4E-76	Terrarium
	√50.5E-78	Aquarium
#51	Plumber	
	51.1E-76	Fishing Pole Holder
	51.2E-77	Quilting Frame
	√51.3E-77	Servicing a "P" or "S" Trap

Getting to Know Materials, A Learning Activity Package

Prepared as an aid in implementing the Wisconsin Guide to local curriculum improvement in industrial ed.1C-12

Summary: The package deals with materials; where they are found; different kinds; and their characteristics and selection.

For further information, contact: The Industrial Education Instructional
Materials Development Project
University of Wisconsin-Stout
Menomonie, Wisconsin 54751

Metals Industry, a prepared curriculum prepared as an aid in implementing the *Wisconsin Guide to Local Curriculum Improvement in Industrial Education*, K-12

Summary: A course designed to supply information and method necessary to teach students about industry in its entirity, rather than just trade skills or narrow subject fields.

For further information, contact: The Industrial Education Instructional
Materials Development Project
University of Wisconsin-Stout
Menomonie, Wisconsin 54751

American Industry, Instructors Guide for Level I and II

American Industry Project

Summary: The course is designed for students in the junior high school. It deals with a study of the basic conceptual knowledge of industry and the solving of simple industrial problems.

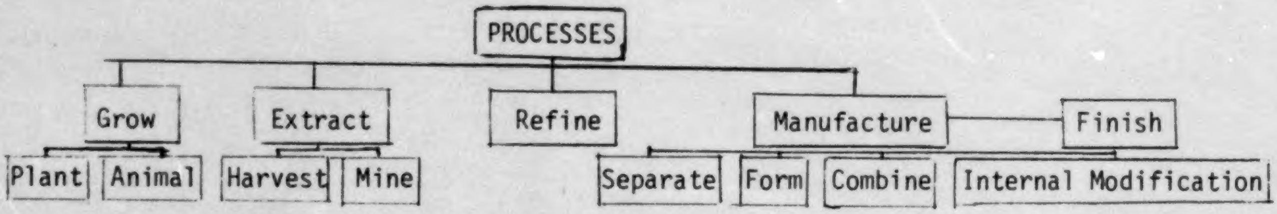
Through a series of classroom and laboratory activities it is intended that the student will develop a broad understanding of industry and its role in society.

For information as to purchase of guides; transparencies; film strips; contact:

American Industry Project
University of Wisconsin-Stout
Menomonie, Wisconsin 54751

University of Wisconsin - Stout

Processes Model



DEFINITIONS

Processes: The systematic series of actions involved in the transformation of materials in the production of goods.

Growing: Natural organic development toward maturity through assimilation of nutriment.

Extracting: Deriving the materials for production from the existing environment.

Refining: The removal or destruction of impurities from a substance or the dividing of a material into its desirable component parts.

Manufacturing: To change the shape, add to, or change some physical characteristic(s) of a raw material(s) such as lumber, steel, wool, thread, plastic, or flour, to produce usable goods.

Separates: The dividing or parting of material or the removal of controlled amounts of material from a main body.

Form: The molding or shaping of material to predetermined specifications by utilizing its fluid or plastic qualities.

Combine: The joining, mixing, compounding, weaving, or otherwise combining of component parts or materials in the production or goods.

Internal Modification: The changing of physical properties by modifying or rearranging the atomic molecular structure of the material without an appreciable removal of material.

Finishings: Changing the surface condition or appearance of a material.

RESOURCES:

Ready access to securing resources in developing an industrial education program are invaluable.

The resources included in the following section of the handbook include guides, texts, journals, educational games and simulations, companies and people.

The resources that are included are not meant to be all inclusive but rather were selected to get the curriculum developer off and running.

REFERENCE BOOKS FOR MATERIAL ANALYSIS & PROCESS

Title: The ABC's of Modern Plastics
Author: Union Carbide
Pub. Co.:
Date:

Title: All About Upholstering
Author: John Bergen
Pub. Co.: Hawthorn Books
Date: 1962

Title: American Technology
Author: Oliver
Pub. Co.: Ronald Press Co.
Date: 1956

Title: America's Handyman Book
Author: Handyman Staff
Pub. Co.: Charles Scrbner's Sons
Date: 1970

Title: Antiques
Author:
Pub. Co.: Valentine & Co.
Date:

Title: Arc Welding Self-Instruction Guide
Author: William Olson
Pub. Co.: Vector
Date: 1967

Title: Art Metalwork With Inexpensive Equipment
Author: Payne
Pub. Co.: Manual Arts Press
Date: 1966

Title: The Art of Woodturning
Author: Klenke
Pub. Co.: Chas. A. Bennett Co.
Date:

Title: Arts-Crafts Lamps
Author: Adams
Pub. Co.: Popular Mechanics
Date: 1911

Title: Autobody Repairing and Repainting
Author: Bill Toboldt
Pub. Co.: Goodheart-Willcox
Date: 1969

Title: Automobile Body Bebuilding and Refinishing
Author: William K. Toboldt
Pub. Co.: International Textbook Company
Date: 1965

Title: Automobile Sheet Metal Repair
Author: Robert L. Sargent
Pub. Co.: Chilton Book Company
Date: 1969

Title: Automotive Collision Work
Author: Venk, Spicer, Davies
Pub. Co.: American Technical Society
Date: 1970

Title: Basic Hand Tools
Author: U.S. Navy – NAVPERS 10085-A
Pub. Co.: U.S. Government Supt. of Documents
Date: 1963

Title: Basic Woodworking Processes
Author: Herman Hjorth M.S.
Pub. Co.: The Bruce Pub. Co.
Date: 1961

Title: Basic Woodwork Projects
Author: McGinnis
Pub. Co.: McKnight & McKnight
Date: 1959

Title: The Book of Arts & Crafts
Author: Ickis
Pub. Co.: Assoc. Press
Date: 1954

Title: Bows and Arrows for Boys
Author: Decker
Pub. Co.: Bruce
Date: 1930

Title: Build-A-Course Series
Author:
Pub. Co.: Goodheart-Willcox
Date:

Title: Building Construction Handbook
Author: Merritt
Pub. Co.: McGraw-Hill
Date: 1958

Title: Cabinetmaking and Millwork
Author: Feirer
Pub. Co.: Chas. A. Bennett
Date: 1970

Title: Cabinetmaking and Millwork
Author: Dahl & Wilson
Pub. Co.: American Technical Society
Date: 1970

Title: Cabinet Making for Beginners
Author: Hayward
Pub. Co.: Lippincott
Date: 1948

Title: Canals and American Economic Development
Author: Goodrich, Carter, and others
Pub. Co.: Columbia University Press
Date: 1961

Title: Captive Rivers
Author: Faber
Pub. Co.: Putnam
Date: 1966

Title: Careers in the Age of Automation
Author: Aulick
Pub. Co.: Hawthorn
Date: 1968

Title: Careers in the Building Trades
Author: Kasper
Pub. Co.: Walck
Date: 1969

Title: Carpentry for the Building Trades
Author: E. A. Lair
Pub. Co.: McGraw-Hill
Date: 1953

Title: Ceramics
Author: Weiss
Pub. Co.: Young Scott Books
Date: 1964

Title: Ceramics
Author: Zarchy
Pub. Co.: Knopf
Date: 1954

Title: Ceramics in the Modern World
Author: Chandler
Pub. Co.: Doubleday
Date: 1968

Title: Children Study American Industry
Author: Harold Gilbert
Pub. Co.: Wm. D. Brown Pub. Co.
Date: 1966

Title: Colonial Craftsmen
Author: Tunis
Pub. Co.: McGraw-Hill
Date: 1965

Title: Colonial Furniture Making for Everybody
Author: Shea
Pub. Co.: Van Nostrand, Reinhold
Date: 1964

Title: Coloring, Finishing and Painting Wood
Author: Newell & Holtrop
Pub. Co.: Chas. A. Bennett
Date: 1961

Title: Commercial Motor Transportation
Author: Charles A. Taff
Pub. Co.: R. D. Irwin Co.
Date: 1961

Title: Common Woodworking Tools
Author: Wyatt
Pub. Co.: Bruce
Date: 1936

Title: Complete Book of Wood Finishing
Author: Scharff
Pub. Co.: McGraw-Hill
Date: 1956

Title: Complete Metalworking Manual
Author: Cooley
Pub. Co.: Arco
Date: 1970

Title: A Concise Guide to Plastics
Author: Simonds, Church
Pub. Co.: Reinhold
Date: 1963

Title: Concrete Form Construction
Author: Industrial & Technical Education
Pub. Co.: Delmar Pub. Inc.
Date. 1969

Title: Construction Ahead
Author: Billings
Pub. Co.: Viking
Date: 1965

Title: Contemporary Industrial Arts
Author: Sekelys
Pub. Co.: McKnight & McKnight
Date: 1956

Title: Contour Sawing Hand Book (9th ed.)
Author: Doall
Pub. Co.: Continental Machines, Inc.
Date: 1941

Title: Cope's Plastics Book
Author: Cope, Dickey
Pub. Co.: Goodheart-Willcox
Date: 1960

Title: Coppercraft and Silver Made at Home
Author: Kramer
Pub. Co.: Clifton
Date: 1957

Title: Corrosion in Action
Author:
Pub. Co.: International Nickel Company
Date: 1961

Title: Course in Wood Turning
Author: Milton, Wohlers
Pub. Co.: Bruce
Date: 1919

Title: Creating with Metal
Author: Granstrom
Pub. Co.: Van Nostrand
Date: 1968

Title: Creative Leathercraft
Author: Petersen
Pub. Co.: Sterling
Date: 1959

Title: Creative Metalworking
Author: Mattson
Pub. Co.: Bruce
Date: 1960

Title: Design and Construction in Wood
Author: Noyes
Pub. Co.: Manual Arts Press
Date: 1913

Title: The Development of American Industries
Author: John Glover and Rudolph Lagai
Pub. Co.: Simmons-Boardman Pub. Co.
Date: 1959

Title: Dictionary of Occupational Titles
Author: U.S. Employment Service
Pub. Co.: U.S. Gov't Printing Office
Date: 1968

Title: Drawing and Planning
Author: Feiler
Publ Co.: Chas. A. Bennett
Date: 1968

Title: Educational Wood Working for Schools and Home
Author: Park
Pub. Co.: Macmillan
Date: 1908

Title: Estimating for the Building Trade
Author: Steinberg-Stempel
Pub. Co.: American Technical Society
Date: 1969

Title: Ethan Allen Treasury (Design & Project Ideas)
Author:
Pub. Co.: Ethan Allen Furniture Co. Outlets
Date: 1971

Title: The Evolution of Mass Prod[illegible]n
Author:
Pub. Co.: Ford Motor Company
Date: 1956

Title: Experiments with Materials & Products of Industry
Author: Arthur W. Earl
Pub. Co.: McKnight & McKnight
Date: 1960

Title: Exploring Patternmaking and Foundry
Author: Miner, Miller
Pub. Co.: Van Nostrand
Date: 1966

Title: The Farm Management Handbook
Author: Hall, Issac, and Mortenson, W.P.
Pub. Co.: Interstate Printers & Publishers
Date: 1963

Title: Fiber Glass Projects & Procedures
Author: Gerald L. Steele
Pub. Co.: McKnight & McKnight
Date: 1962

Title: Fiberglass Reinforced Plastics
Author: Sonneborn, Dietz, Heysen
Pub. Co.: Reinhold
Date: 1954

Title: Finishing Materials & Methods
Author: Soderberg
Pub. Co.: McKnight & McKnight
Date: 1959

Title: The First Book of Skyscrapers
Author: Creighton
Pub. Co.: Watts
Date: 1964

Title: Floor Maintenance Manual
Author: Morris Wertenberger
Pub. Co.: Trade Press
Date: 1968

Title: Forging and Welding
Author: Robert E. Smith
Pub. Co.: McKnight & McKnight
Date: 1967

Title: Foundry Practices
Author: Rusinoff
Pub. Co.: American Technical Society
Date: 1964

Title: From Spinning Wheel to Spacecraft
Author: Neal
Pub. Co.: Messner
Date: 1964

Title: From Trees to Paper
Author: Lent
Pub. Co.: Macmillan
Date: 1952

Title: Fundamentals of Carpentry, Vo. I & II
Author: Durbahn & Sandberg
Pub. Co.: American Technical Society (4th ed.)
Date: 1970

Title: Fundamentals of Carpentry
Author: Durbahn
Pub. Co.: American Technical Society
Date: 1967

Title: Furniture
Author:
Pub. Co.: Century Furniture Company
Date: 1930

Title: Fun With Junk
Author: Goda
Pub. Co.: Crown
Date: 1966

Title: Fun With Wire
Author: Leeming
Pub. Co.: Lippincott
Date: 1956

Title: General Industry
Author: Lindbeck, Lathrop
Pub. Co.: Chas. A. Bennett
Date: 1969

Title: General Metal
Author: Fraser and Bedell
Pub. Co.: Prentice-Hall
Date: 1962

Title: General Metals
Author: Feirer
Pub. Co.: McGraw-Hill
Date: 1959

Title: General Plastics
Author: Raymond Cheryy
Pub. Co.: McKnight & McKnight
Date: 1967

Title: General Theories of Operation
Author:
Pub. Co.: Briggs and Stratton Corp.
Date:

Title: General Woodworking
Author: Groneman
Pub. Co.: McGraw-Hill
Date: 1964

Title: General Woodworking
Author: Groneman
Pub. Co.: McGraw-Hill
Date: 1955

Title: 56 Graded Problems in Elementary Sheet Metalwork
Author: Anderson
Pub. Co.: McKnight & McKnight
Date: 1959

Title: Halfway Elements
Author: Chedd
Pub. Co.: Doubleday
Date: 1969

Title: Handicraft in Plastics
Author: Richards
Pub. Co.: Chas. A. Bennett
Date: 1948

Title: High Timber: The Story of American Forestry
Author: Charles I. Coombs
Pub. Co.: The World Publishing Co.
Date: 1960

Title: Home Mecnanics
Author: Schaefer
Pub. Co.: Bruce
Date: 1961

Title: How A House is Built
Author: Benenson
Pub. Co.: Criterion
Date: 1964

Title: The How-To Book of Carpentry
Author: DeCristoforo
Pub. Co.: Arco
Date: 1963

Title: How To Do Your Own Wood Finishing
Author: Hand
Pub. Co.: Harper & Row
Date: 1967

Title: How To Make Wood Furnishing for the Home
Author: Dal Fabbro
Pub. Co.: McGraw-Hill
Date: 1965

Title: Handyman's Book
Author:
Pub. Co.: Better Homes and Gardens
Date:

Title: Home Appliance Servicing
Author: Edwin P. Anderson
Pub. Co.: Howard Sams & Co.
Date: 1969

Title: How-To-Do-It Encyclopedia
Author:
Pub. Co.: Golden Press
Date: 1961

Title: Industrial Arts Plastics
Author: Edwards
Pub. Co.: Chas. A. Bennett
Date: 1964

Title: Industrial Organization and Management
Author: Lawrence L. Bethel
Pub. Co.: McGraw-Hill
Date: 1962

Title: Industrial Processes Control
Author: Zess, Delahooke
Pub. Co.: Delmar Pub.
Date: 1961

Title: Industrial Structure and Policy
Author: Stanley Vance
Pub. Co.: Prentice-Hall
Date: 1961

Title: Instructional Units in Hand Woodwork
Author: Tustison, Brown, Barocci
Pub. Co.: Bruce
Date: 1965

Title: Jewelry Making for the Amateur
Author: Lewes
Pub. Co.: Reinhold
Date: 1965

Title: Jigs and Fixtures for Limited Production
Author: Sedlik
Pub. Co.: Society of Manuf. Engineers
Date: 1970

Title: The Key To Metal Bumping
Author: Frank T. Sargent
Pub. Co.: Fairmount Tool & Forging, Inc.
Date: 1953

Title: 56 Lamps
Author: Graffam
Pub. Co.: General Pub. Co.
Date: 1949

Title: Leatherwork Manual
Author: Stohlman, Patten, Wilson
Pub. Co.: Tandy Leather Co.
Date: 1969

Title: Low-Cost Wood Homes for Rural America–Const. Manual
Author: L. O. Anderson
Pub. Co.: U.S. Govt. Print. Office
Date: 1969

Title: Manufacturing Methods and Processes
Author: Ansley
Pub. Co.: Chilton
Date: 1968

Title: The Magic of Rubber
Author: Dreany
Pub. Co.: Putnam
Date: 1960

Title: Machines That Built America
Author: Burlingame
Pub. Co.: Harcourt
Date: 1953

Title: Making Mosaics
Author: Arvois
Pub. Co.: Sterling
Date: 1964

Title: Machine Processes
Author:
Pub. Co.: Delmar Pub.
Date:

Title: Man, Metals, and Modern Magic
Author: Parr
Pub. Co.: Collier
Date: 1958

Title: Machine-Tool Work
Author: Turner
Pub. Co.: McGraw-Hill
Date: 1945

Title: Machine Drafting and Related Technology
Author: Yankee
Pub. Co.: McGraw-Hill
Date: 1966

Title: Materials of Construction
Author: R. C. Smith
Pub. Co.: McGraw-Hill
Date: 1966

Title: Machine Tool Metalworking
Author: Feirer & Tatro
Pub. Co.: McGraw-Hill
Date: 1961

Title: Machining Fundamentals
Author: Walker
Pub. Co.: Goodheart-Willcox
Detr: 1969

Title: Machine Shop
Author: Porter, Lascoe, Nelso
Pub. Co.: American Technical Society
Date: 1967

Title: Materials & Products of Industry
Author: Earl
Pub. Co.: McKnight & McKnight
Date: 1960

Title: Manufacture of Plastics
Author: Smith
Pub. Co.: Reinhold
Date: 1964

Title: Marvels of American Industry
Author: Donald Cooke
Pub. Co.: C. S. Hammond & Co.
Date: 1962

Title: Manufacturing in the School Shop
Author: Haws and Schaefer
Pub. Co.: American Technical Society
Date: 1968

Title: Metals
Author: Wohlrabe
Pub. Co.: Lippincott
Date: 1964

Title: Meet the Plastics
Author: Robinson
Pub. Co.: Macmillan
Date: 1951

Title: Metal Sculpture
Author: Lynch
Pub. Co.: Viking
Date: 1957

Title: Measurement and Layout
Author:
Pub. Co.: Delmar
Date:

Title: Mechanics of Materials (2nd ed.)
Author: Levinson
Pub. Co.: Prentice-Hall
Date: 1970

Title: Metalwork Technology & Practice
Author: Ludwick-McCarthy
Pub. Co.: McKnight & McKnight
Date: 1969

Title: Metallurgy
Author: Weeks
Pub. Co.: American Technical Society
Date: 1956

Title: Metalworking
Author: T. Gardner Boyd
Pub. Co.: Goodheart-Willcox
Date: 1964

Title: Metalwork, Technology and Practice
Author: Oswald A. Ludwig
Pub. Co.: McKnight & McKnight
Date: 1962

Title: Meeting the New Attack on Today's Distribution
Author:
Pub. Co.: National Assoc. of Manufacturers
Date: 1960

Title: Miracle Plastics
Author: Newcomb
Pub. Co.: Putnam
Date: 1964

Title: The Miracle of Plastics
Author: Cook
Pub. Co.: Dial
Date: 1964

Title: Milling Machine Work
Author:
Pub. Co.: Delmar Pub.
Date: 1953

Title: Modern Machine Woodworking
Author: Holtrop
Pub. Co.: Bruce
Date: 1960

Title: More Modern Wonders and How They Work
Author: Leyson
Pub. Co.: Dutton
Date: 1955

Title: Modern Wood Technology
Author: Hackett-Spielman
Pub. Co.: Bruce
Date: 1968

Title: Mosaic Techniques
Author: Stribling
Pub. Co.: Crown
Date: 1966

Title: Mosaics
Author: Young
Pub. Co.: Reinhold
Date: 1957

Title: Modern Metalcraft
Author: Young
Pub. Co.: Reinhold
Date: 1957

Title: Modern Wrought Iron Furniture
Author: Frisbie
Pub. Co.: Bruce
Date: 1959

Title: Modern Welding
Author: Althouse
Pub. Co.: Goodheart-Willcox
Date: 1970

Title: Modern Woodworking
Author: Willis H. Wagner
Pub. Co.: Goodheart-Willcox Co.
Date: 1970

Title: Modern Carpentry
Author: Willis H. Wagner
Pub. Co.: Goodheart-Willcox
Date: 1969

Title: Modern Refrigeration and Air Conditioning
Author: Althouse, Turnquist, Bracciano
Pub. Co.: Goodheart-Willcox
Date: 1968

Title: Modern Metal Working
Author: Walker
Pub. Co.: Goodheart-Willcox
Date: 1965

Title: Modern Welding
Author: Althouse, Turnquist, Bouditch
Pub. Co.: Goodheart-Willcox
Date: 1967

Title: Modern Plastics
Author: Harry Barron
Pub. Co.: John Wiley and Sons Inc.
Date: New York, New York 1945

Title: Nature of Metals (2nd ed.)
Author: Rogers
Pub. Co.: American Society for Metals
Date: 1964

Title: The New World of Plastics
Author: Alfred Lewis
Pub. Co.: Dodd, Mead & Co.
Date: 1963

Title: Nonmetallic Minerals
Author: Ladoo and Meyers
Pub. Co.: McGraw-Hill
Date: 1964

Title: Occupational Outlook Handbook
Author: U. S. Bureau of Labor Statistics
Pub. Co.: U. S. Govt. Printing Office
Date: 1968

Title: Opportunities in Building Construction
Author: Sumichrast, McMahon
Pub. Co.: Voc. Guid.
Date: 1971

Title: Opportunities in Ceramic Engineering
Author: Scholes
Pub. Co.: Voc. Guid.
Date: 1967

Title: Opportunities in Machine Shop Trade
Author: Stern
Pub. Co.: Universal
Date: 1969

Title: Opportunities in Management Careers
Author: Place
Pub. Co.: Voc. Guid. Man.
DAte: 1969

Title: Opportunities in Plastics Careers
Author: Dearle
Pub. Co.: Voc. Guid.
Date: 1963

Title: Organization for Production
Author: Roscoe
Pub. Co.: Irwin
Date: 1967

Title: Organization for Production
Author: Roscoe
Pub. Co.: Irwin
Date: 1959

Title: Painting and Decorating Encyclopedia
Author: William Brushwell
Pub. Co.: Goodheart-Willcox
Date: 1964

Title: Plant Layout and Materials Handling
Author: Apple
Pub. Co.: Ronald Press
Date: 1963

Title: Plastering Skill & Practice
Author: Van Den, Branden, and Knowles
Pub. Co.: American Technical Society
Date: 1953

Title: Plasticizers
Author: Buttrey
Pub. Co.: Franklin
Date: 1960

Title: Plastic Molding: A Comprehensive Study
Author: Chemical Pub. Co.
Pub. Co.:
Date: 1941

Title: Plastics
Author: Buehr
Pub. Co.: Morrow
Date: 1967

Title: Plastics
Author: Lauton Edwards
Pub. Co.: Bennett
Date: 1964

Title: Plastics
Author: Cope & Conaway
Pub. Co.: Goodheart-Willcox
Date: 1966

Title: Plastics Extrusion Technology
Author: Griff
Pub. Co.: Reinhold
Date: 1962

Title: Plastics in the Modern World
Author: Couzens & Yarsley
Pub. Co.: Pelican Books
Date: 1968

Title: Plastics: Projects and Procedures With Polyesters
Author: Alexander Fredrick Bick
Pub. Co.: Bivre Pub. Co.
Date: 1962

Title: Plastics Technology
Author: Swanson
Pub. Co.: McKnight & McKnight
Date: 1965

Title: Plumbing
Author: Harold Babbitt
Pub. Co.: McGraw-Hill
Date: 1960

Title: Plumbing
Author: Matthias, Jr. and Smith, Sr.
Pub. Co.: American Technical Society
Date: 1970

Title: Pottery Made Easy
Author: Dougherty
Pub. Co.: Bruce
Date: 1939

Title: Practical Carpentry
Author: Mix
Pub. Co.: Goodheart-Willcox
Date: 1963

Title: Practical Designs for Drilling, Milling & Tapping Tools
Author: Hinman
Pub. Co.: McGraw-Hill
Date: 1946

Title: Practical Handbook of Plumbing and Heating
Author: Richard Day
Pub. Co.: Arco Pub. Co.
Date: 1969

Title: Practical Wood Patternmaking
Author: Hall
Pub. Co.: McGraw-Hill
Date: 1943

Title: Preparation of Metals for Painting
Author: Spring
Pub. Co.: Rinehold
Date: 1965

Title: Principles and Practices of Light Construction
Author: Smith
Pub. Co.: Prentice-Hall
Date: 1962

Title: Principles of Color and Color Mixing
Author: Bustanoby
Pub. Co.: McGraw-Hill
Date: 1967

Title: Principles of Management
Author: Koontz, Harold, and O'Donnell, Cyril
Pub. Co.: McGraw-Hill
Date: 1964

Title: Principles of Woodworking
Author: Holtrop & Hjorth
Pub. Co.: Bruce
Date: 1961

Title: The Production and Properties of Plastics
Author: Kate Leon
Pub. Co.: International Textbook Company
Date: 1947

Title: Production Control
Author: Moore, Jablonski
Pub. Co.: McGraw-Hill
Date: 1969

Title: Projects in General Metalwork
Author: Ruley
Pub. Co.: McKnight
Date: 1951

Title: Projects for Metals
Author: Walker
Pub. Co.: Goodheart-Willcox
Date: 1957

Title: Projects in Woodwork
Author: Douglas
Pub. Co.: McKnight & McKnight
Date: 1953

Title: Refinishing Furniture
Author: Kuhn
Pub. Co.: Arco
Date: 1963

Title: Riches From The Earth
Author: Fenton
Pub. Co.: J. Day Co.
Date: 1953

Title: Rigid Plastics Foams
Author: T. H. Ferriano
Pub. Co.: Reinhold Pub. Co.
Date: 1963

Title: Rubber
Author: Evelyn M. Graham
Pub. Co.: Firestone Tire and Rubber Co.
Date: 1963

Title: Simple Bracelets
Author: Bollinger
Pub. Co.: Bruce
Date: 1951

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1119 "A" STREET
TACOMA, WASHINGTON 98401

SHELL FILM LIBRARY
1433 SADLIER CIRCLE WEST DRIVE
INDIANAPOLIS, INDIANA 46239

IDEAL AUDIO VISUAL SERVICE
4431 WEST NORTH AVENUE
MILWAUKEE, WISCONSIN 53208

CONSOLIDATED PAPER
ADMINISTRATIVE ASSISTANT
PUBLIC RELATIONS DEPARTMENT
WISCONSIN RAPIDS, WISCONSIN 54494

WESTERN ELECTRIC
FILM LIBRARIAN
195 BROADWAY
NEW YORK, NY 10007

GENERAL MOTORS CORPORATION
PUBLIC RELATIONS STAFF FILM LIBRARY
GENERAL MOTORS BUILDING
DETROIT, MICHIGAN 48202

MODERN TALKING PICTURE SERVICE
FILM SCHEDULING CENTER
2323 NEW HYDE PARK ROAD
NEW HYDE PARK, NY 11040

MOTION PICTURE BUREAU
CHICAGO TRIBUNE
435 NORTH MICHIGAN AVENUE
CHICAGO, ILLINOIS 60611

KEARNEY AND TRECKER CORPORATION
11000 THEODORE TRECKER WAY
MILWAUKEE, WISCONSIN 53214

ASSOCIATION INSTRUCTIONAL MATERIALS
866 THIRD AVENUE
NEW YORK, NY 10022

UNDERWRITERS LABROTORIES
SEE: MODERN TALKING PICTURE SERVICE

OVER THE COUNTER INFORMATION BUREAU
2 BROADWAY
NEW YORK, NY 10004

DEPARTMENT OF EDUCATION
A.M.C. & B.W.-N.A.
2800 NORTH SHERIDAN ROAD
CHICAGO, IL 60657

GRINDING WHEEL INSTITUTE
2130 KIETH BUILDING
CLEVELAND, OHIO 44115

WEST GLEN COMMUNICATIONS
565 FIFTH AVENUE
NEW YORK, NY 10017

BOYD FILM SERVICE
LIBERTY BANK BUILDING
SNELLING AVENUE AT SELBY
ST. PAUL, MN 55104

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
4800 FORBES AVENUE
PITTSBURGH, PENNSYLVANIA 15213

Sources for Audio-Visual Materials

Allied Chemical Corporation
Plastics Division
40 Rector Street
New York, New York 10006

Branson Sonic Power Company
Division of Branson Instruments, Inc.
Miry Brook Road
Danbury, Connecticut 06910

Celanese Plastics Company
744 Broad Street
Newark, New Jersey 07102

Ciba Chemical and Dye Company
Route 208
Fair Lawn, New Jersey 07410

Dow Chemical Company
Visual Aids Department
Midland, Michigan 48640

E. I. duPont de Nemours and Company, Inc.
Motion Picture Section
Advertising Department
1007 Market Street
Wilmington, Delaware 19898

Eastman Chemical Products, Inc.
Chemicals Division
260 Madison Avenue
New York, New York 10016

Elliott Film Company
1114 Nicollet Avenue
Minneapolis, Minnesota 55403

Enjay Chemical Company
Division of Humble Oil and Refining Company
Headquarters Film Library
P.O. Box 2180
Houston, Texas 77001

Epoxylite Corporation
1428 North Tyler Avenue
South El Monte, California 91733

Filon Corporation
Advertising Department
12333 South Van Ness Avenue
Hawthorne, California 90250

General Electric Company
Chemical Materials Department
1 Plastics Avenue
Pittsfield, Massachusetts 01201

B. F. Goodrich Company
Public Relations Department
Akron, Ohio 44318

Houdry Process and Chemical Company
Urethane Chemicals Department
1528 Walnut Street
Philadelphia, Pennsylvania 19102

Interchemical Corporation
Public Relations and Promotion Department
67 West 44th Street
New York, New York 10036

Koppers Company
Plastics Division
Koppers Building
436 7th Avenue
Pittsburgh, Pennsylvania 15219

Marbon Chemical Company
Division of Borg-Warner Corporation
P.O. Box 68
Washington, West Virginia 26181

Mobay Chemical Company
Penn Lincoln Parkway West
Pittsburgh, Pennsylvania 15205

Molded Fiber Glass Boat Company
Division of Molded Fiber Glass Body Company
55 4th Avenue
Union City, Pennsylvania 16438

Northwestern Bell Telephone Company
Public Relations Department
Film Booking — Room 1335
224 South 5th Street
Minneapolis, Minnesota 55402

Pennsalt Chemicals Corporation
E. J. Stokes Division
Book Department
3 Penn Center
Philadelphia, Pennsylvania 19102

Reichhold Chemical, Inc.
Advertising Department
525 North Broadway
White Plains, New York 10602

Ren Plastics, Inc.
5656 South Cedar Street
Lansing, Michigan 48910

Rohm and Hass Company
Independence Mall West
Philadelphia, Pennsylvania 19105

Sinclair-Koppers Company
Koppers Building
436 7th Avenue
Pittsburgh, Pennsylvania 15219

Stout State University
Audio-Visual Department
Menomonie, Wisconsin 54751

Strong Plastics, Inc.
1821 West 60th Street
Los Angeles, California 90047

Swedlow, Inc.
6986 Bandini Boulevard
Los Angeles, California 90022

Union Carbide Corporation
Plastics Division
Advertising Department
270 Park Avenue
New York, New York 10017

Uniroyal, Inc.
Director of Public Relations
1230 Avenue of the Americas
New York, New York 10020

United States Gypsum Company
101 South Wacker Drive
Chicago, Illinois 60606

Waldron-Hartig Company
Division of Midland-Ross Corporation
Sales Department
1137 Globe Avenue
Mountainside, New Jersey 07092

Westinghouse Electric Corporation
Micarta Division
Hampton, South Carolina 29924

OTHER FILM SUBJECTS CAN BE RESEARCHED BY CONTACTING SPECIFIC MANUFACTURERS OF PRODUCTS AND ASKING FOR FILM LISTS.

The following is a list of specific film titles for use in the Material and Processes area.

Bureau of Audio-Visual Instruction (BAVI) Film Reference Guide
Phone: (608) 262-1644
First Class Mail: P.O.Box 2093
Madison, Wisconsin 53701
Parcel Post and Film Mail: 1327 University Avenue
Madison, Wisconsin 53701

TITLE	CATALOG NO.	LENGTH
EARTH: RESOURCES IN ITS CRUST		
FROM TREES TO LUMBER	2889	12 min.
FROM TREES TO PAPER	0793	14 min.
IRON ORE MINING	1098	14 min.
LOGGING IN WISCONSIN IN 1938	0791	13 min.
OIL WELL (SHELL 1977)	2103	21 min.
PETROLEUM (REFINING)	1667	10 min.
RUBBER FROM OIL	4793	33 min.
SYNTHETIC FIBER: NYLON AND RAYON	2163	14 min.
WISCONSIN: MANUFACTURING AND MINING	4136	20 min.
COPPER, STEWARD OF THE NATION	6453	12 min.
MAKING BRICKS FOR HOUSES	1331	10 min.
MAKING GLASS FOR HOUSES	1332	11 min.
HARVEST FROM THE FOREST	1796	13 min.
FIBERGLASS	3523	13 min.
PLASTICS: INDUSTRIAL PROCESSES AND PRODUCTS	5551	25 min.
METAL WORK MACHINE OPERATIONS: FASTENING METALS	4318	13 min.

MODERN TALKING PICTURE SERVICE, INC.
FILM SCHEDULING CENTER
2323 NEW HYDE PARK ROAD
NEW HYDE PARK, NY 11040

PPG: FLASS FOR THE SEVENTIES	4231	12 min.
THE MAGIC OF REFINING	31073	
CHEMICALS: A FACT OF LIFE		27 min.
SCRAP! (Bell Telephone System, Recycling)		13 min.

E.I. DUPONT DE NEMOURS AND CO., INC.
ADVERTISING DEPARTMENT
AUDIO VISUAL SECTION
WILMINGTON, DELAWARE 19898

THE WAY IT IS WITH MAN - MADE FIBERS	27 min.
THE WONDERFUL WORLD OF NYLONG	13 min.

Sources for Instructional Materials

Allied Chemical
Plastics Division
P.O. Box 365
Morristown, New Jersey 07960

American Handicrafts Company
1109 Nicollet Avenue
Minneapolis, Minnesota 55403

American Insulator Corporation
1930 Main Street
New Freedom, Pennsylvania 17349

Anchor Plastics
3636 36th Street
Long Island City, New York 11106

Bakelite Company
Division of Union Carbide Corporation
270 Park Avenue
New York, New York 10017

Branson Sonic Power Company
Eagle Road
Danbury, Connecticut 06810

Celanese Plastics Company
744 Broad Street
Newark, New Jersey 07102

Chemical Products Corporation
King Philip Road
East Providence, Rhode Island 02914

Comet Industries
1320 North York Road
Bensenville, Illinois 60106

Dake Corporation
390 Robbins Road
Grand Haven, Michigan 49417

Dow Chemical Company
Plastics Department
Abbott Road
Midland, Michigan 48640

Ferro Corporation
Color Division
4150 East 56th Street
Cleveland, Ohio 44105

General Tire and Rubber Company
Chemical Plastics Division
70 Garden Street
Lawrence, Massachusetts 01841

B. F. Goodrich Chemical Company
3135 Euclid Avenue
Cleveland, Ohio 44115

Industrial Arts Supply Mail Order Company
1408 West Lake Street
Minneapolis, Minnesota 55408

Interchem Corporation
Finishes Division
1255 Broad Street
Clifton, New Jersey 07013

International Plastics Industry Consultants, Inc.
P.O. Box 1324
Long Island City, New York 11101

Koppers Company
Marketing Department
Koppers Building
436 7th Avenue
Pittsburgh, Pennsylvania 15219

McGraw-Hill Book Company
330 West 42nd Street
New York, New York 10036

Milwaukee Chair Company
3022 West Center Street
Milwaukee, Wisconsin 53245

Mobay Chemical Company
Penn Lincoln Parkway West
Pittsburgh, Pennsylvania 15205

Monsanto Company
Plastic Products and Resins Divisions
800 North Lindbergh Boulevard
St. Louis, Missouri 63166

Nopco Chemical Company
175 Schuyler Avenue
North Arlington, New Jersey 07032

Owens-Corning Fiberglas Corporation
5217 Wayzata Boulevard
Minneapolis, Minnesota 55416

Phillips Petroleum Company
Plastics Division
Bartlesville, Oklahoma 74003

Pittsburgh Plate Glass Industries
Fiber Glass Division
1 Gateway Center
Pittsburgh, Pennsylvania 15222

Prodex Corporation
Division of Koehring Company
King George Post Road
Fords, New Jersey 08863

Reinhold Publishing Corporation
430 Park Avenue
New York, New York 10022

Rohm and Hass Company
Plastics Department
Independence Mall West
Philadelphia, Pennsylvania 19105

Shell Chemical Company
Plastics and Resins Division
6054 West Touhy Avenue
Chicago, Illinois 60648

Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

Union Carbide
4815 West 77th Street
Minneapolis, MN 55424

U.S. Industrial Chemicals Co.
3701 Wayzata Boulevard
Minneapolis, MN 55416

United Merchants & Manufacturers, Inc.
1407 Broadway
New York, NY 10018